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BY

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ANOMALOUS CIRCULATION IN THE EYE.

By E. G. LORING, M.D., of New York.

(With Colored Plate B.)

The following cases, believed to be unique, are presented as examples of the effect which morbid processes may produce on the circulation of the eye, and the curious manner in which Nature may, under such conditions, seek to remedy the evil.

It is certainly a very curious, and at the same time very interesting fact, that, although from the anatomical labors of Zinn, Jaeger, and Leber an anastomosis between the choroidal and retinal vessels has been supposed to exist (at least in the immediate neighborhood of the nerve), no such anastomosis has ever been actually seen with the ophthalmoscope.

Anomalies in distribution and course, of both retinal and choroidal vessels, are certainly mentioned in the various text-books and journals; but a true case of a direct communication between these two sets of vessels has, so far as I am aware, never been reported.

Recognizing the important rôle which such a communi-

cation would play in morbid processes, I have diligently searched with the ophthalmoscope, for the past three years, for such a condition, and as the result of these labors I can only produce three cases in which there were any sufficient grounds to suppose that an anastomosis might exist.

In all these cases accurate drawings were made from repeated examinations through a dilated pupil, both with the upright and inverted image, and these were subsequently compared with the appearances in the living eye, by colleagues whose skill in the use of the instrument was a guarantee for the correctness of the observations.

These cases, briefly stated, are as follows :—

Case I.—This is the case from which the chromo-lithograph is taken, and the appearances here figured (Tab. B, fig. 1) were found in the right eye of a young man of sound bodily health, who, curiously enough, consulted us, not in regard to this, but the fellow-eye, in which he had experienced some slight asthenopic symptoms. The examination of this eye (the left) showed that there was a positive astigmatism of $\frac{1}{18}$, with vision a little better than $\frac{2}{3}$. There was also some slight conjunctival trouble, but in all other respects, certainly as far as the ophthalmoscopic appearances were concerned, the eye was perfectly normal.

As, however, there was a divergent squint of some $2\frac{1}{2}$ lines in the right eye, this was also examined, though the patient asserted that it gave him no inconvenience whatever.

From the ophthalmoscopic appearances which the eye presented (Tab. B, fig. 1) it was at first surmised that the patient must have experienced, at some former time, a violent concussion in the neighborhood of the eye, which had been followed by an extensive rupture of the choroid, with subsequent atrophy of the surrounding region. A

careful inquiry, however, failed to produce the slightest grounds for such a belief, and the following brief statement was all that could be elicited in explanation of the appearances:—

Some ten years before the patient had had a chancre, for which he had been treated in the regular way. Two years ago he had again contracted the disease, which was followed by secondary symptoms; and the patient remembers to have had, shortly afterwards, violent pain in both eyes, with great dread of light, for which he was treated by a quack, and which gradually wore away. Since then he has experienced no pain or trouble in this eye, though he was aware that he could not see so well with it as with the fellow-eye.

The refraction, as measured by the ophthalmoscope, was $M = \frac{1}{20}$ and vision was reduced to counting fingers in two feet. There was a central scotoma corresponding more or less exactly to the extent of the injury, which, as will be seen from the picture, stretches from near the border of the nerve outwards to a distance equal to about four diameters of the nerve, while its vertical measurement is about three diameters. This, of course, includes the yellow spot, and accounts for the central scotoma. Eccentric vision seemed to be, however, relatively normal.

In absence of direct proof in regard to the cause of the trouble, it is very certain, from the ophthalmoscopic appearances themselves, that it is not a congenital condition, but the result of a somewhat extensive and deep-seated inflammatory action, most probably, as the history shows, of specific origin.

Thus we see, from the drawing which is taken with the upright image, that the inner half of the nerve is atrophic, and contains a redundancy of connective tissue; while the vessels themselves, even at a distance from the large central patch of atrophic and degenerated choroidal and retinal tissue, show the traces of a marked perivasculitis.

The point, however, of *particular interest* centres in the behavior

of the larger vessels of the lower half of the fundus. As will be seen, the principal artery is bordered, and in part covered, by hypertrophied connective tissue, which is of a brilliantly white and feathery appearance when illuminated by the ophthalmoscope. This extends for a considerable distance along the vessel, and reduces in a marked degree its apparent size. This decrease is, however, I think, to be looked upon as apparent rather than real, as we should otherwise be obliged to infer that there had been originally a stoppage of this vessel by embolism or thrombosis, with a subsequent dilatation of the more distant parts, brought about through the agency of an anastomosis with some neighboring vessels. I am particular in mentioning this, as I cannot help thinking that this partly masking of a vessel by the surrounding tissue, especially when the portion of a vessel thus concealed is of small extent, and when the examination has been made with the inverted image, has led to the erroneous conclusion that the calibre of the vessel was reduced, or even that it was completely closed. Nor is it at all probable that any anastomosis exists in the lower part of the vessel, by means of which its increase in size could be accounted for. If any such did in reality exist, in this or any other case, the vessels forming it ought to be visible in so transparent a tissue as the retina, when seen, as with the upright image, under an enlargement of fifteen diameters.

That the retinal vessels do transform themselves into apparent white cords, under the influence of perivasculitis and inflammation of the walls of the vessels themselves, is undoubtedly true; but that they ever do so from simple embolism we doubt very much. At any rate, it appears to us impossible that such a transformation could have taken place from such a cause in the short space of two days, as is alleged in Dr. Saemisch's case of embolism of a branch of the central artery. There can be no doubt that the vessel had been also in

that case subjected for some time previous to inflammatory processes.

More interesting, however, than the evidences of perivasculitis, and which is indeed the chief feature of interest in the case, is the *remarkable behavior of one of the lower principal veins.*

This, as a glance at the plate will show, ascends towards the nerve in the normal manner till it reaches a point about two diameters of the disk from the edge of the nerve, where, instead of continuing on in the natural way, it makes a sudden bend at a comparatively acute angle, and then runs in the same direction with and parallel to the neighboring artery, the currents of the two vessels moving in the same direction. After making a sweeping curve upward, this part of the vein is joined by another large branch coming from the left of the field, and the two then uniting to form one trunk, this latter passes directly upwards, crosses over the artery, and then comes to an abrupt end, its point of termination being masked, in a provoking manner, to a considerable degree, by a spot of pigment lying over the vessel.

As, however, neither the main trunk of the vessel nor any branch thereof makes its appearance in any part of the fundus, one of two things must take place, namely, either the vessel pierces the sclera, thus making for itself an independent exit from the eye into the orbital cavity, and uniting there with some orbital vessel; or it forms, sooner or later, some anastomosis inside of the eye with

one of the larger choroidal vessels. If it be true, as Leber asserts, that there are no veins which empty out of the posterior part of the eye, then it is extremely improbable that this vessel should so far violate the law as not simply to enlarge an exit already existing, but to bore for itself an outlet through so dense and resisting a tissue as the sclera; while, on the contrary, there is certainly little against the supposition that the vessel should join one of the choroidal veins.

Another interesting feature is the peculiar course of the vessel. It is probable that the principal trunk of the vein lay in the very focus of the inflammatory action, and was by this completely destroyed, and subsequently absorbed down to the apex of the angle formed by the sudden bend in the vessel.

Thus its connection with the nerve, as is obvious from the drawing, is entirely cut off for a considerable distance, not a vestige of the vessel or its remains being visible with the ophthalmoscope.

It is probable, too, that the angle mentioned above is the junction of what were originally two secondary branches joining the principal branch of the vein; and if this is so (and we cannot very well account otherwise for the sharpness of the angle), it is certainly curious that the blood should flow (that is, in the left leg of the angle) in just the opposite direction from what it did originally, and from what Nature intended it should. That the venous current here flowed away from the nerve, and not towards it, was undoubtedly the case.

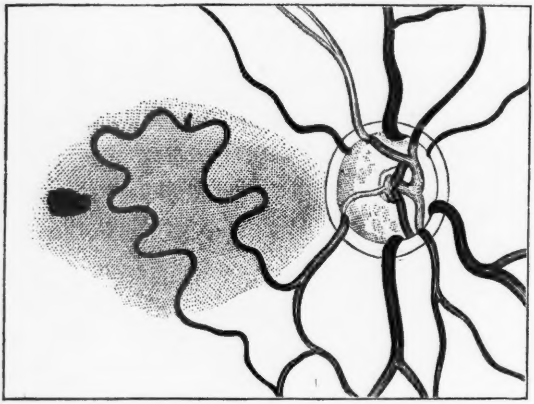
We thus have two exits for the venous circulation of the retina: one at the optic disc, the other at the seat of the injury.

Case II.—The second case is that of a middle-aged woman who had lost the left eye in early childhood, which had atrophied to a mere button. Until about four months before visiting us she had had no trouble from her right eye, when she was attacked with all the rational signs of acute glaucoma, which passed after a time into a chronic condition, from which she was still suffering, though in a reduced degree, at the time of her visit.

As the patient was suffering a great deal of pain, and as the nature of the disease was very apparent, although no view of the fundus could be obtained on account of the troubled condition of the media, iridectomy of the right, with removal of the atrophied bulb of the left, which was also inflamed, was performed at once. The vision in the right eye was so bad before the operation that only an intensely bright light could be perceived. After the operation, however, vision finally improved so much that the patient could go abroad, and count fingers, in a good light, at ten feet.

The media cleared up, so that a perfectly good view of the fundus could be obtained; and the adjoining figure represents the ophthalmoscopic appearances three months after the operation.

As will be seen, the nerve was deeply excavated, and presented in all respects the classic picture of glaucoma. A deep-gray opacity in the retina extended from the outer edge of the optic nerve to the macula, which appeared as a blackish oval spot. Through this gray opacity, and occupying a part of the retina usually free from vessels, ran a branch from one of the principal trunks of the central artery. This vessel was of a considerable size, and pursued an exceedingly tortuous course, twisting in and out in a remarkable manner, till it finally doubled on itself, returning nearly to where it started from, and then passed out of view in the extremity of the field. In about the centre of the convoluted part this arterial branch was joined by a short trunk



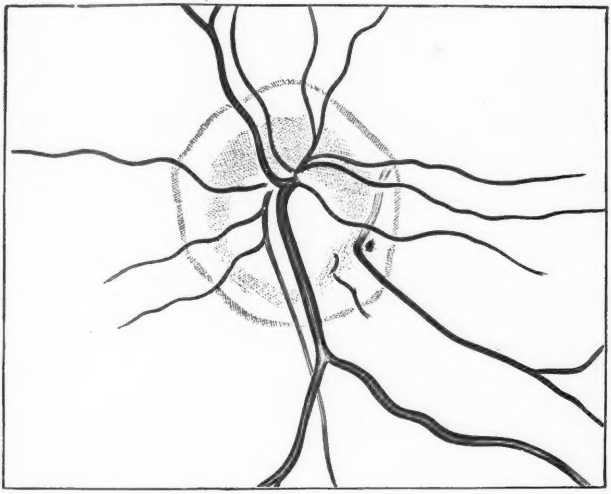
of about equal or a little larger calibre with itself, which seemed to come up in a sort of rounded, arch-like projection from some vessel lying in the deeper tissues either of the retina or choroid, and by means of which the size of the tortuous vessel was increased, not only at the point of juncture, but also for quite a distance beyond.

It certainly does not appear at the first sight as likely that the supplementary vessel should come from the choroid, as it would have to pierce the pigment epithelium and other tissues, which, for some reason or other, seem to offer an almost insurmountable barrier to the union between choroidal and retinal vessels, and thus to render the independence between these two sets of vessels almost an absolute one. Still the fact that no other retinal vessel of even the smallest size could be detected in the neighborhood, would go far to prove that the vessel was of choroidal and not retinal origin.

Be this as it may, it is certain that Nature endeavored,

by anastomosis, to supply a part whose nourishment had suffered from morbid processes.

Case III.—The appearances represented in the next figure were found in the left eye of a young girl who was suffering from progressive myopia, the result of over-work at school.



The patient was myopic $\frac{1}{4}$, and the fundus showed the signs of a well-marked posterior staphyloma of that rather rare form which surrounds the entire nerve; and the line of separation between the nerve and adjoining sclera was so faintly marked as to give the impression of an enormously large disk, upon which the ramifying vessels stood out with great clearness.

The particular point of interest was, however, that the atrophy, as it progressed, had spared what either was originally, or had become, a vein of considerable size. This vessel, taking its origin from the upper and inner part of the field, ran downwards and outwards, as if to pass out with or join one of the other vessels at the centre of the disk.

After passing over the atrophied portion, however, and just before it reached the true border of the nerve, it made a sudden turn, and was then traceable directly into what was evidently a choroidal vessel. At the point of bending there was what seemed to be a faintly perceptible pulsation, and the lower portion of the vessel seemed to be on a plane posterior to its other portion, as if here the wall of the eye was, in fact, slightly staphylomatous.

Here, as with the first case, one of two things must hold good: either the vein pierces the sclera, and thus makes an outlet for itself; or it joins with one of the choroidal vessels, as really seemed with the ophthalmoscope to be the case.

CLINICAL AND ANATOMICAL OBSERVATIONS.

By Dr. J. HIRSCHBERG,
Lecturer at the University of Berlin.

(With Colored Plate A, Fig. 1, and Plate IX., Figs. 1–4.)

(*Translated by Dr. C. C. Terry, of New York.*)

1. Cysticercus Intra-ocularis.[1]

In a former number of these Archives (Vol. I. No. 2) I indicated the possibility of diagnosticating cysticercus intra-ocularis, even where the refracting media are perfectly opaque. To-day I am enabled to confirm this statement by a new example.

Jan. 1, 1871. William K., a peasant, æt. 20 years, from G., in the province of Brandenburg, came to my clinic with the complaint that his right eye had been attacked with a severe inflammation, on the last Christmas, after being a year blind without pain.

The eye now showed no sign of irritation; scarcely a trace of pericorneal injection, but more apparent after a closer examination; form, position, and tension normal; cornea clear; numerous posterior synechiæ; lens transparent. In the moderately-dilated pupil appeared a yellowish reflex; under focal illumination this became a whitish reflex from a bright convex surface lying immediately behind the lens, where, after removal of the eye, was seen a red streak. Ophthalmoscope

showed nothing more. S=0. Right eye slightly hypermetropic, and vision good. Patient otherwise healthy. Glioma could be excluded by the age of the patient; indeed, any intra-ocular tumor, by the normal tension; the anamnesis excluded traumatic and metastatic choroiditis. So there remained only cysticercus intra-ocularis as the probable diagnosis, and this was the diagnosis recorded.

Believing that here, as in the former case, the attempt to extract the cysticercus with conservation of the eye would be subservient to a surgical vanity rather than promotive of the good of the patient, by reason of the shrinking of the eye after the necessary equatorial section, phthisis dolorosa, and the danger which I have a number of times seen realized of sympathetic affection of the other eye, I decided upon enucleatio bulbi. This was accomplished in the usual manner, and gave the usual result.

After thirty hours' hardening, the eye was opened horizontally, and I found, as shown in fig. 1, Tab. IX., a funnel-shaped detachment of the retina by serous exudation. Between a roundish, outwardly convex fold of the retina and the shrunken condensed vitreous body lay the expected cysticercus, in a globular, smooth-walled nest. Cornea, sclerotic, iris, lens, nerv. opt., and choroid but little changed. In the equatorial region of the lower half of the preparation the choroid, elsewhere well covered by its pigmentary layer, was adherent, over a space of several lines, to the retina, which here appeared as a bell-shaped projection from its small pedicle at the papilla.

At this place, probably, the entozoon escaped from the choroidal region by perforating the retina to reach to vitreous chamber. At first sight the retina had the

usual aspect of a total detachment, the posterior portion infundibular, and the anterior bell-shaped, but showing two convex prominences, one of which ran downwards to the adhesion with the choroid, while the other spread out laterally and concealed the nest of the cysticercus. The outer wall of this nest was formed by the retina, the inner by the corpus vitreum, which lay in the retinal funnel like another funnel, or rather as a pyramidal body of a somewhat more regular shape, and consisting of a soft, yellowish mass, which, under the microscope, showed the well-known felt of fine fibrillæ. The retina exhibited connective-tissue degeneration, and was loosely connected with the corp. vitr. The cysticercus is smaller —corresponding to its age of about twelve months— than either of those previously described by me. (Virchow's Arch. LV., and these ARCHIVES, l. c.)

To the five hitherto published cases of cysticercus inclosed in the human eye, which I have collected in my first paper, there are to be added three observations of mine and one by Prof. Saemisch (Zehender's Monatsbl., 1870, 170). The bed of the cysticercus, in the most of the cases where it could be clearly made out, was subretinal. So it was in both of the cases formerly published by me, in Saemisch's, and in the first one of Jacobson. In the present case, on the contrary, it appears, as happened in one of Alf. v. Graefe's cases, that the site of the cysticercus was anterior to the retina. The fact that in so short a time I have made three such observations, and that in two of these cases, in spite of the turbidity of

the refracting media, the diagnosis was clear, shows, at least for our country, the importance of this parasitic disease of the eye.

Explanation of Tab. IX., *Fig.* 1.

Eyeball with cysticercus. Sclera, cornea, iris, optic nerve apparent without designation.

ch = Choroid.

r = Retina, infundibuliform detachment; its lateral halves form a convex fold, the lateral walls of

cc = nest of the cysticercus.

v = Infundibular shrunken vitreous body.

2. Sarcoma of the Lower Eyelid.

With the exception of epithelial cancer of the cutaneous surface, progressive, malignant neoplasmata of the substance of the eyelid are so rare that in thorough text-books the subject is either omitted or the existence of such tumors is flatly denied. Wecker (Maladies des Yeux, second edit., 1867, I., 654 et seq.) speaks of sarcoma of the eyelids only vaguely, and of carcinoma as follows: Le carcinome ne s'observe presque jamais aux paupières. . . . Zehender, Soelberg Wells, and others do not even allude to it. Yet such productions do occur.

In May, 1869, I extirpated a carcinoma from the conjunctiva of the upper lid of an elderly man* (v. Zehender's Monatsbl., 1869, 191 et seq.); and a short time

* The result is still—Jan., 1870—entirely satisfactory.

ago I had occasion to remove an immense tumor from the thickness of the lower lid of a little boy.*

Dec. 31, 1870. Hugo Z., six years of age, was sent to my clinic from abroad, on account of a very high degree of ectropium; and certainly, as will be seen, the case deserved the old name of ectropium sarcomatosum, but in another than the usual sense.

The anamnesis indicated that at the end of October, 1870, the lower lid of the left eye became "green and yellow;" that since eight weeks it had been considerably thickened without pain, and that since that time the child had been pale, thin, and without appetite.

Stat. præs. In the region of the left eye is a tumor as large as an apple, which (as shown in the colored Pl. A, Fig. 1, and Tab. IX., Fig. 2) is substantially an intumescence of the lower lid. Between the free margin of the everted lower and the margin of the upper lid bulges a broad fold of thickened conjunctiva, which, as though in conseqence of constant exposure, appears velutinous and deep red. The part of the tumor exposed by forcible abduction of the upper lid is pale, whitish, pretty firm, and traversed by a few vessels. It is absolutely impossible to bring the eyeball into view from behind the summit of the tumor; its condition is therefore provisionally left unascertained.†

The intumescence of the lower lid is elastic, and at one circumscribed spot which projected most, and is indicated in the drawing, there is fluctuation. The skin over the tumor is freely movable, whilst at the infra-orbital margin it seems to be closely adherent; still, the bony

* In my monograph on Medullary Sarcoma of the Retina I have incidentally mentioned a lardaceous tumor of the lower eyelid of an adult, removed by Prof. v. Gräefe, which presented the structure of a small-celled sarcoma; there is also cited an observation of Schirmer (Zehender's Monatsbl., 1867, 124) on sarcomatous degeneration of all four lids.

† If the ensemble of the clinical description, together with the anamnesis, did not speak sufficiently for the palpebral origin of the neoplasm, a further argument would be the backward propulsion of the bulbus—in contradistinction to the exophthalmus observed in orbital neoplasmata.

border is nowhere so obscured that it cannot be felt. The neighboring lymphatics seem to be intact.

The patient appears otherwise healthy, excepting his pallor and weakness.

The diagnosis of malignant neoplasm of rapidly progressive growth (sarcoma) seemed indubitable, and the necessity for an operation was rendered more urgent by the prospect of a speedy adhesion of the skin to the tumor, which would make the extirpation all the more difficult.

Jan. 2, 1871. I operated in the following manner: The palpebral fissure was extended at the outer commissure by an incision of $1\frac{1}{2}''$ and the conjunctiva dissected from the cutaneous margin for the whole length; then along the line of the wound the skin of the lid covering the tumor, and of the cheek, was dissected without injuring the tumor, and turned down. The upper lid was detached and turned up, and then the tumor, with its lobulated, bluish-red surface, came into view. By means of a convex bistoury it was detached from the infra-orbital margin, freed from the floor of the orbit by sawing movements of the knife, and drawn forward by Muzeux forceps. It was then easy to pass the finger between the summit of the tumor and the upper lid, and to feel the soft bulbus beyond, and further preparation discovered it to be intimately attached to the tumor by its inferior surface. To save it would be impossible; and so, to shorten the operation, not so much from fear of the slight bleeding as of the deep and prolonged narcosis, the tumor was separated from the globe by a diagonal incision—thus removing nearly the whole mass. The bulbus was then extirpated, with the attached fragment of neoplasm. After clearing away some neoplastic patches from the floor of the orbit, the periosteum was felt to be thickened, and the bone depressed. The infra-orbital margin was cleared to the bone, the thickened portions of periosteum removed, and two applications of the actual cautery made to the suspicious points of bone. After assuring myself that no disease had been left in the orbit, the cavity was filled with a sponge wrapped in linen, the lids returned, and a firm bandage applied.

The sponge was removed in 12 hours; a part of the sutures in 24, and the remainder in 36 hours. Besides carefully cleansing the cavity with water every two hours, it was injected with solutio zinci sulpho-phenylici (4.0 : 100.0) and then filled with a dossil of lint steeped in the same solution.

The reaction was insignificant; the cutaneous wound healed per primam; suppuration was moderate, and the cavity soon filled with healthy granulations. The appetite increased; the boy recovered his ruddy color, and was discharged cured Jan. 21, 1871.

Fresh sections of the preparation showed throughout a white medullary substance, dashed with grayish hyaline streaks, varied with a considerable number of bloody points, and several cavities, some of which were quite small, others reaching and even surpassing a lentil in diameter.

The bulbus exhibited at its lower aspect a considerable area of the peculiar oblation already considered by me in Zehender's Monatsbl., 1869, 67. Within it was no visible trace of the neoplasm; its three membraneous layers were separable, and the retina could easily be lifted in folds which radiated in all directions.

After hardening in Müller's fluid, a microscopical examination of the tumor discovered the structure of a *small-celled sarcoma.* Not all parts were equally characteristic, but there appeared to be an irregular alternation of parts in which the cells were abundant with parts in which they were few. In the first-named parts, even very thin sections, prepared with carmine, showed hardly anything but closely aggregated, roundish, or slightly oblongated nuclei, enclosed in cells which were comparatively small, roundish, or in the form of short

spindles; the scanty intercellular substance consisted of delicate fibrillæ and nucleoli. In the more loosely textured parts these structural relations are better seen; here and there are more perfect spindle and stellate cells, and here also the great vascularity of the tumor is marked: —numerous coarse and fine vessels traverse the tissue, with capillary networks in some places as dense as in many glandular organs, and large, roundish, and oblong cavities manifest themselves, by the concentric arrangement of their walls, to be the sections of blood-vessels. In some preparations are two anastomosing networks interlaced, one formed by the blood-vessels, and the other by peculiar tubes whose double-contoured walls were made up of thickly aggregated cells. (Conf. the case of neoplasm described by me in Zehender's Monatsbl., 1869, p. 153.)

The above minutiæ render unnecessary any special description of Colored Plate A, Fig. 1, and Tab. IX., Fig. 2.

3. GLIOMA RETINÆ IN THE FIRST STAGE.

As a complement to the account of glioma retinæ attempted in this series of notes, I may add the following *case in which the disease is found in its first stage, and entirely confined to the retina.*

Dec. 29, 1870, I received from Dr. Driver, of Chemnitz, an enucleated bulbus, preserved in Müller's fluid, with the accompanying history:—

"Dec. 23. Gustav M., æt. 2½ years, born there of healthy parentage and grand-parentage, having lately had small-pox, and still bearing signs of rachitis, was brought to my clinic by his mother, on account of a whitish appearance in the left eye, which she first observed some four weeks ago.

"Right eye normal; iris blue. Left eye of normal form and size, but tension somewhat diminished; iris bluish gray; pupil easily dilated by atropine. An exquisite picture of 'amaurotic cat's eye.'

"The ophthalmoscope discovered certain white, glistening bosses, reaching forward to near the lower border of the lens, traversed by vessels, and separated from the disc to the equator by a deep interspace. The neoplasm did not entirely fill the vitreous chamber, and above the red choroid was visible; but neither its vessels nor those of the retina could be made out.

"Glioma retinæ was diagnosticated, and on the 27th of December the eye was enucleated."

Jan. 7, 1871, the bulbus was opened on its *vertical* meridian. Tab. IX., Fig. 3, shows the section of the outer half, and Fig. 4 that of the inner half. It was quite evident that the disease was limited to the retina, for all other parts of the preparation were intact, and the retina itself, superiorly and laterally, was delicate and transparent, corresponding to the red reflex observed with the ophthalmoscope before the enucleation.

Only below, the retina, from the papilla forwards, was transformed into a considerable neoplasm, which reached a height to nearly half fill the cavum bulbi, and when raised by dissecting needles from the underlying choroid, it enabled one to see that the above-mentioned interspace was formed by a strip of retina which, reaching from the disc to the ora serrata, and scarcely increased in thickness, was beset with little miliary masses upon its external surface; elsewhere the retina merely showed some thickening, which gradually decreased from the disc forwards, and when turned back it discovered, upon the otherwise unchanged choroid, a great many fine white

points which, far from being glioma nests in the proper stroma of the choroid—as vertical sections proved—were merely deposits of glioma cells upon the pigment epithelia, and, together with the epithelia, were easily swept off by means of a fine pencil.

The retinal tumor exhibited the *usual structure of glioma. The optic nerve was quite normal*, which is not to be wondered at, as the careful mother observed the abnormal reflex only four weeks ago.

This case has great likeness to the one with which I commenced my monograph, "Markschwamm der Netzhaut." That patient now, after a period of three years, shows no sign of relapse, but on the contrary, is a splendid example of the truth of the proposition first made and supported by me,* viz., that glioma of the retina in its first stage is a local disease curable by early enucleatio bulbi.

Explanation of Table IX., Figs. 3 *and* 4.

Vertical section of an eye affected with glioma retinæ.

L = lateral part. o = superior aspect.
M = median part. u = inferior aspect.

* *Editorial Remark.* The author is not correct in claiming the priority of this proposition. *Virchow*, in his work on Morbid Growths, speaks of glioma as not necessarily malignant, and I have at different places of my treatise on Intra-ocular Tumors dwelt upon the possible benignity of the first stage of retinal glioma. On page 86 of the German, and on page 124 of the English edition is the following remark: "Though the statistics thus far are very discouraging, the possibility of preserving life by the removal of the eye, in cases where glioma of the retina is recognized at an early period, seems to me undeniable and well supported by convincing anatomical data." J. Hirschberg, in his paper on Glioma, which appeared at the same time with my treatise, adduces arguments only for the malignity of glioma (See Graefe's Arch. XIV. 2, p. 98: Prognosis of Glioma).

H. KNAPP.

ON GLIOMA RETINÆ.

By Dr. J. HIRSCHBERG,
Lecturer at the University in Berlin.

(Tab. IX., Fig. 5.)

Translated by Dr. C. C. Terry.

In reply to a written invitation from Prof. Knapp, I have furnished the anatomical details of the following new case of glioma retinæ, and the more willingly because, notwithstanding the rapid and important advances in the literature of this remarkable disease, there are upon record but a few cases of pure glioma of the retina.

Indeed, to the seven cases which I collated two years ago* only two have been added,† and both examples of glioma retinæ endophytum. Although, in agreement with most investigators‡ who have had large fields of observation, I hold § that malignant intraocular neoplas-

* Der Markschwamm der Netzhaut, v. Dr. J. Hirschberg, 1869, p. 6–17. The cases are reported respectively by Hirschberg, Arch. f. Ophth. xiv., 2, 34, 1868; Manfredi, Rivista clinica, May, 1868; Prof. Knapp, die intraocularen Geschwülste, 1868, p. 5-27; Schweigger, Arch. f. O., vi., 2, 324, 1860; A. v. Graefe, ibid., vii., 2, 42–45, 1861; Virchow, Onkologie ii., 159; Sichel et Robin, Iconographie Ophthalmologique, p. 582.

† Iwanoff, Arch. f. Ophth., xv., 2, 69, 1869; J. Hirschberg u. L. Happe, ibid., xvi., 1, 297, 1870—add to this Schiess-Gemuseus, Zehender's Monatsbl., July, 1870.

‡ Knapp, l. c.; v. Graefe, Arch. f. O., xiv., 2, 105, 1868.

§ Markschwamm, p. 87.

mata of the infantile eye, with the complex of symptoms characterized as "amaurotic cat's eye," constantly originate in the retina, it is worth while, in view of the small number of anatomically probative cases, to strengthen our conviction by new proofs.

To Dr. Driver, of Chemnitz, my thanks are due for the preparation and history of the following case:—

"Bertha Linke, æt. 2½ years, born in Bielefeld, a blonde with blue irides, came of healthy parentage, and, excepting a doughy face and frequent attacks of eczema capitis, appeared always well until three or four weeks ago, when the mother noticed a changed appearance of the right eye.

"Stat. præs. August 1, 1870. Strabismus converg. o. d. 2½‴; mobility in all directions intact; right eye harder than left, but cornea clear, and no trace of pericorneal injection or inflammatory irritation; iris discolored, yellowish; pupil moderately dilated, rigid, and giving a bright reflex—an exquisite picture of 'amaurotic cat's eye.' After speedy and complete dilatation of the pupil with atropine, it was apparent that the whole of the vitreous chamber was occupied by a yellowish-white neoplasm, which was moulded to the posterior convexity of the transparent lens, and traversed by numerous vessels. S=0.

"Aug. 3, 1870, enucleatio bulbi, the eye being drawn well forwards and a piece of optic nerve 3‴ in length snipped off with the scissors. The piece of nerve was immediately examined for glioma structure, but none found. Healing occurred in the usual manner, with no relapse up to the time of writing (Dec. 27, 1870)."

The preparation, laid in Müller's fluid and sent to me the next day, was opened Aug. 10.

In form, the eye was unchanged; its horizontally transverse diameter measured 22 mm.; the antero-posterior ½ mm. less. On opening the eye in the horizontal

meridian, a small quantity of clear, yellowish fluid escaped, but the greater part of the vitreous chamber was occupied by a solid medullary mass, whose retinal origin became clearly distinguishable, and all the more interesting from the large volume of the tumor. Beyond the clear cornea the sclera, as well as the attached fragment of optic nerve, showed no signs of disease, nor did the uveal tract. The lens was transparent and its ligaments normal.

The retina could be traced as a membranous structure only in the outer part of the preparation, and even here it exhibited considerable pathological changes. The pars ciliaris and neighboring zonula were still sufficiently thin and transparent to permit the uvea to be seen as a dark back-ground, though abnormally opaque, and exhibiting a great number of small whitish foci, which appeared upon the internal aspect of the membrane as fine points or submiliary nodules, and, as further preparation showed, projected from the external surface as a multitude of flat, white nodules, many of them larger than a hemp-seed, tending to confluence and thickly aggregated —suggesting the appearance of a serous membrane undergoing the development of acute miliary tuberculosis.

Measured at the equator, the thickening of the retina was ¾–1 mm.; thence the membrane extended in delicate folds* towards the optic entrance, where it became part of the root of the tumor; while, in the upper half of the

* Perhaps from the action of the preservative fluid.

preparation, the outer portion of the retina appeared as a moderately and pretty uniformly thickened layer.

The neoplasm was imbedded in the inner [nasal] part of the retina, and the mass projected so far across toward the outer wall of the bulbus as to leave of the cavum vitreum only a space which upon the section appeared as a narrow crescent, 5 mm. at the widest, with the anterior horn just behind the lens, and the posterior horn corresponding to a neck-like constriction of the tumor in front of the optic papilla. The inner [nasal] surface of the mass, lying upon the choroid, was rugose; *and here the retinal tissue was entirely lost in the tumor*, which was chiefly of a yellowish-white color, sprinkled with numerous grayish insular patches. Just under the free surface was a hemorrhagic focus as large as a pea. The substance of the tumor was remarkably soft, and exhibited several smaller hemorrhagic foci; under a stream of water it easily resolved into shreds and fibres. Blood-vessels were discernible only by the aid of a magnifying lens—probably in consequence of the action of the hardening fluid.

Further preparation by equatorial section through the sclera and choroid showed both these membranes everywhere normal, and brought into view the warty external surface of the tumor, as well as the above-mentioned small foci in the unthickened portion of the retina.

Under the microscope the tumor exhibited the usual structure—thickly aggregated, small, round cells. Transverse sections of the thinnest and apparently normal

parts of the retina exhibited its original stratification. Three distinct layers were visible : a middle opaque layer largely composed of round cells, and two peripheral layers composed of radiating fibres, intermingled with round cells. Sections of those portions of the retina already spoken of as thickened, and exhibiting miliary foci, discovered that at these points the middle layer swelled into heaps of round cells. Of the two limiting membranes at these places, the external was convex and delicate, the internal more plane, well marked, and supplied with a distinct frame-work of fibres.

Choroid and opt. nerve perfectly normal, and free from glioma foci.

In an anatomical point of view this case is noteworthy, inasmuch as, notwithstanding the large size of the growth, it was still confined to the retina.

It also evinces the practical value of such anatomical investigations in a clinical point of view.

Within a few weeks of the commencement of these morbid symptoms an exact diagnosis is possible, and upon it depends the success of the therapeutics—early enucleatio bulbi.

Explanation of Pl. IX., Fig. 5.

r=Retina somewhat thickened, sprinkled with small foci.

R=Tumor retinæ.

ENGORGED PAPILLA (STAUUNGS-PAPILLA) IN CONSEQUENCE OF SOLITARY TUBERCLE IN THE CEREBELLUM.

BY DR. J. HIRSCHBERG,
Lecturer at the University in Berlin.

Translated by Dr. C. C. Terry.

ENGORGED papilla depending upon solitary tubercle of the brain is not so often observed that a proper case will be without interest.

In my Annual Report of the Ophthalmic Clinic., S. 6 (Berliner Klinische Wochenschrift, 1870, Nr. 44, II., 1), the anamnesis of the case is noted as follows:—

Flora L., æt. 3 years, March 29, 1869. L. neuritis optici and very marked engorged papilla; optic nerve reddish, dull, very prominent; its borders somewhat indistinct and swollen. Veins very tortuous, following the curves of the papilla, and not covered. No hemorrhages. Retina otherwise unchanged.

R. Neuritis optici. Disc slightly prominent, paler and more clouded than left, so that the venous branches lying upon the papilla were slightly veiled, whilst also dilated and very tortuous; arteries rather small.

Absolute bilateral amaurosis, with no evidence of perception of light. Strabism. converg. o. s. was said by the mother to have been present earlier than the present affection, and her account is supported by the fact that the left eye suffered from recurrent keratitis circumscripta. Sensorium intact. The intelligent little child complained of headache, especially when subjected to examination.

The anamnesis showed that the child was well up to Christmas,

1869; that she then became feverish, and complained of headache; and although suffering no loss of consciousness, she kept the head inclined backwards and to the right. The attending physician thought it to be inflammation of the brain. Headache, drowsiness, and languor persisted, and she was unable to move about. When placed upon her feet she cannot sustain herself; yet there does not appear to be actual paralysis of any of the four extremities.

About a fortnight ago her aunt discovered that she was blind, though the mother had not suspected it. Diagnosis: tumor cerebri.

April 20.—Still no perception of light; pupils moderately dilated, and not reacting. Considerable emaciation, peevish temper, fever. Sensorium intact.

The left papilla is less prominent; its tissue pale and dull; the inferior veins still greatly dilated and tortuous. The right papilla is not prominent, but pale and bleached.

Oct. 21, 1870.—The child is peevish and lachrymose, and disinclined to talk; but the mother thinks her still sensible. The head is much increased in volume, and cannot be sustained. Bilateral amaurosis; l. strabism. converg., pupil half dilated. R. mydriasis. Papillæ dirty white, not swollen; veins dilated. The four extremities are slightly contracted, but not perfectly paralyzed. She can hold objects with the left hand. There is dysphagia and extreme emaciation.

At last the child became unconscious, could not swallow, and died Jan. 3, 1871.

I made the section in the afternoon. The body was extremely emaciated, the four extremities contracted, the cranium enormously enlarged, with thin bones and wide sutures. In taking out the swollen brain there was a gush of more than a pint of serous fluid, and the hemispheres collapsed proportionately.

Hydrocephalus externus et internus.

All the ventricles were dilated, and the medullary

layer of the hemispheres thin. In the right half of the cerebellum was found a hard, dry, yellow, cheesy mass as large as an apple, composed of concentric laminæ, and containing at its centre a focus of white detritus. The left half of the cerebellum was attached to the basis cranii by means of a white cheesy mass as large as a walnut.

An examination of the eyes was not permitted.

CONTRIBUTIONS TO THE PATHOLOGY OF GLIOMA RETINÆ.

By Dr. J. HIRSCHBERG, of Berlin, and Dr. J. KATZ, of Essen.

Translated by Dr. C. C. Terry.

(With Colored Plate A, Fig. 2.)

Although every new case of glioma retinæ, especially in its earliest stages, affords enough of interest, we should hardly have published the two following cases but for the favorable opportunity offered by the liberal editors of these Archives to give a very faithful representation * of one of the preparations, with all its natural blending of tints, for the benefit of those who have not yet had the chance to make such observations.

1. Maria H., of Essen, from a healthy family, though weakly from birth, had a chest disorder in March, 1870, and at the end of May she was observed to squint with the right eye. After the mother's attention had been attracted to the eye she observed that it appeared to grow rapidly larger and "blacker." In November the patient's friends recognized a perfect abolition of sight on that side.

Dec. 1, 1870. One of us (K.) found the following condition: there is a slight and regular enlargement of the eye, and its tension is increased (T.+2). The cornea is clear, and the sclera white; pupil dilated ad maximum; lens slightly opaque at its posterior periphery, but permit-

* A very faithful picture—not merely schematic—of medullary sarcoma of the retina is to be found in Sichel's Iconographie, but not in the earlier stage of the disease.

ting illumination of the fundus by directly, and still better by obliquely, transmitted light.

The fundus gives a yellowish-gray reflex, and exhibits a bright-colored neoplasm whose surface lacks the characteristic vascular branches, and projects, by distinct roundish bosses, above the level of the adjacent retina. The proposed enucleatio bulbi was, as usual, objected to, especially as several colleagues consulted by the parents advised against it, since amaurosis ("schwarzer Staar") is an incurable disorder. (The diagnosis and pathology of medullary sarcoma of the retina are still not familiarized in the profession.) But the striking changes which occurred in the eye in the course of a few days—rapid increase of volume and perfect opacity of the lens*—determined the parents to ask for the operation, which, with the after-treatment, was accomplished in the usual manner.

The preparation lay in dilute alcohol until December 17, 1870, and was then carefully examined. The eye was unchanged in form, and without comparison could not be regarded as abnormally large, since its antero-posterior diameter measured 21·5 mm., and the transverse diameter 22 mm. The attached stump of the optic nerve was thickened and reddish-gray, the cornea clear, lens milky, pupil wide, and iris not atrophic.

After section of the eye on the horizontal meridian a few drops of fluid escaped. The sclero-corneal capsule appeared intact, but at the optic entrance the sclera was slightly thickened by the interposition of a thin and narrow reddish-gray stripe between the white anterior and posterior lamellæ, and at this place the sclera was closely adherent to the thickened choroid. The anterior cham-

* Conf. C. G. Lincke, Tract. de fungo medull. oculi, Lips., 1834, p. 54; extract in "Markschwamm der Netzhaut."

ber was not perceptibly diminished, and contained no pathological products. The lens was opacified by a diffuse milkiness. Despite the yellowish-green discoloration of the vitreous it was still sufficiently transparent to permit a view of the retinal changes in the equatorial region, though intermingled with delicate whitish membranes which stretched from the lens backward to the fundus, as shown in the drawing.

The posterior region of the vitreous chamber was occupied by a neoplasm reaching, on the inner side, from the region of the optic entrance towards the equator, and on the outer side quite to it, and distinguishable as consisting of two portions, a retinal and a choroidal.

Upon the section-surface of the lower half of the preparation the retinal portion appeared less considerable than the choroidal; it began with a comparatively thin and delicate grayish scape directly at the papilla, in the angle between the two choroidal expansions, projected 4 mm. into the vitreous cavity, and stretched out upon each side as a flat, thickened layer lying upon the choroid, but nowhere intimately attached to it. This retinal neoplasm was of a fluid consistency, snow-white anteriorly, and rosy-red posteriorly, in consequence of the development of a great number of fine blood-vessels, visible in some places only by means of a magnifying lens. By far the greater part of the retina on the internal [nasal] side was delicate, transparent, not thickened, and normally applied to the other coats of the eye; while at the outer side the retina formed a flat detachment

which, on account of the dissection being made before the perfect action of the hardening fluid, gave the appearance of being too large for the underlying parts.

The transition of the normal retinal tissue into the neoplasm was gradual; for at the anterior extremity of the tumor, which appeared upon the section-surface as an acute angle, the retina could be traced a distance of several lines as a distinct layer, gradually becoming assimilated to the neoplastic tissue, until it was completely lost. At the optic entrance the tumor developed downward but a few lines, and the floor of the eye, as seen through the vitreous, displayed imbedded in the delicate retina two small white swellings, one miliary, the other the size of a lentil and figure-of-eight-shaped —evidently formed by the confluence of two smaller foci.

The upper half of the preparation (Colored Plate A, Fig. 2) exhibited the same reddish-gray pedicle between the thickened optic nerve and the principal mass of the retinal tumor, which also, as in the lower sections, expanded laterally, presenting a mass as large as a hazel-nut kernel, and, with the exception of a reddish part adjoining the papillary region, having a white, medullary aspect. Its convex peak overreached the equatorial vertical plane to within about 5‴ of the posterior surface of the lens. Here also the retina overlay the tumor, fusing with its tissue behind the peak.

In the equatorial region, similarly as in the lower section, was a white mass, as large as a pea, formed by

the confluence of four smaller foci; and near the papillary region was a second, miliary mass, projecting by a convex surface above the level of retina.

On both sides of the optic entrance the choroid formed a lamina of 2–3‴ maximum thickness, extending on the outer side beyond the equator, on the inner side scarcely half so far, and suddenly toning down into the normal uvea. The neoplastic part had a reddish-gray color and more fleshy consistence. The pigment layer of the choroid was generally defective, being perfect only at the ora serrata, in a horizontal zone several lines in width, which has been cut into parallel parts by the section of the preparation, and at the part (denoted in the figure by R_1) near the large focus of confluence. The optic nerve is thickened to $3\frac{1}{2}$‴; upon the section-surface it is white only in the middle, reddish-gray on both sides, and lacking its normal striæ.

For the sake of further preparation the pedicle of the retinal tumor was cut through, and the retina, together with the enclosed corpus vitreum coagulated by Müller's fluid, turned backward.

The choroid contained no neoplastic foci; but its free pigmentary surface was covered by soft glioma masses, which evidently were deposited by precipitation from the retina. The external surface of the retina exhibited numerous folds, and the above-mentioned nodules projected from it convexly.

Microscopical examination of the retinal tumor discovered pure glioma tissue. Besides the innumerable

roundish nuclear cells there was was a remarkable proportion and development of blood-vessels, which despite their thin and homogeneous walls had a calibre of 0.12 mm. and over, and which, by their numerous anastomoses, furnished a frame-work for the soft mass of the tumor. Vertical sections through those parts of the retina which contained the small circumscribed nodules, appeared quite similar to those figured in "Markschwamm der Netzhaut," Tab. I., Figs. 3 and 4; only, in the present case, the changes were somewhat further advanced, the nodules larger, studded upon their external convex surfaces with secondary prominences, and growing inward to the limitans interna; and the neighboring tracts of retina, though unchanged in thickness, were so filled with round cells as to destroy the appearance of a distinct membrane.

The choroidal tumor is of the small-celled variety, but richer in fibres. In the transition to the thin parts of the choroid there were numerous small nodules, most of them just under the pigmentary epithelial layer, some lifting it, and others cropping out, and somewhat resembling the sub-epithelial glioma nests described by Knapp. At a short distance from these nodules the choroid was normal; the deposition of masses of glioma upon the pigmentary epithelial layer could not be regarded as a pathological product of the choroid. The optic nerve was thoroughly infiltrated with small, round cells, and on this account a bad prognosis was made, and an early relapse expected.

Explanation of Colored Plate A, Fig. 2.

Cornea, Sclera, Iris, and Lens, not specially denoted.

r and r_1=unthickened retina.

R=retinal tumor, white, with circumscribed reddish spots.

R_1=disseminated nodules in the retina.

ρ=pedicle of the retinal tumor.

n=thickened optic-nerve.

ch=normal choroid.

Ch and Ch=thickened choroid.

II. July 3, 1870.—William St., of Rheydt, æt. two years, was brought to one of us (K.) on account of an ulcerated tumor of the right eyeball, as large as an apple. The child was well nourished, even ruddy, enjoyed the best of appetite, slept well, and performed the principal functions normally. Several confrères had made a lethal prognosis, and declined to operate. In consideration on the one hand of the general good condition of the child, and on the other hand the great inconvenience and frightful aspect of the local affection, extirpation was advised; for although it might not postpone the fatal event, it would at least make the patient's last weeks or months more endurable.

The tumor was easily segregated from the neighboring tissues, and removed from the orbit in toto; the reaction was slight. But on the fifth day after operation there appeared a swelling of the parotid * of the opposite side, solid, nowhere fluctuating. Under simple remedies (local cataplasms, and resolvents internally), the swelling became smaller, but somewhat harder.

The tumor, examined July 5, 1870, had the size of a small apple, and upon section was found to consist of an interior intra-ocular and a posterior retro-ocular part.

* Compare Knapp, Intraoc. Geschwülste, pp. 50–55; Hirschberg, Markschwamm der Netzhaut, pp. 39, 128, 131, 158; and Zehender's Monatsbl., 1869, March.

The eye itself was of nearly normal size, but the sclera was thin, and the cornea had entirely disappeared, to give way for the projecting fungus.

The intra-ocular portion of the tumor consisted of two parts, viz.: a central gold-colored nucleus as large as a bean, lying somewhat posteriorly—evidently the retinal primary tumor, and, surrounding this, a shell of grayish-white medullary substance in contact with the sclera—the secondary development from the uvea. This shell, pretty thin posteriorly, expanded on the one side to a tumor as large as a bean, on the other side as large as a filbert, and had an exquisite medullary composition. The anterior free surface of the larger tumor had an intense deep-red color, like a hæmatodes. The inner surface of the uveal tumor exhibited pigment detritus. The retro-ocular portion was medullary and vascular; the optic nerve was thickened, citrine. The microscope showed glioma structure, and in the gold-colored nucleus fatty degeneration and accumulation of pigment derived from blood.

From the anatomical data a relapse should be expected in from two to three, or at farthest six months. The further history of the case is shortly told.

At first there was considerable improvement, but a relapse followed, and the child died Aug. 3.

LIVING LARVÆ IN THE HUMAN EAR.

By CLARENCE J. BLAKE, M.D., of Boston.

The occurrence of larvæ of diptera in the human ear is not uncommon, and forms one of the most disagreeable complications of cases of otitis media purulenta. That they should be found generally accompanying that class of affections of the ear characterized by the existence of a copious and often offensive discharge is explainable by the fact that the diptera are guided by the sense of smell in their search for food, and for a depository for their young. "Insects are pre-eminently gifted with the sense of smell. No flock of vultures can be directed more unerringly to their revolting prey by scenting its odors from afar. That the sense of smell alone directs the blow-fly in the deposition of her eggs has been fully proved by the fact of her having, through misguided instinct, been found to lay them on silk wherewith tainted meat has been covered, or upon the ill-odored stapelius, a tribe of hot-house plants, which in scent greatly resemble it." *

That comparatively few cases are recorded is due, probably, not to the infrequency of the deposit of the eggs or larvæ in the ear, but to the fact that they are

* Wood, Episodes of Insect Life. London, 1867, p. 84. See also Pouchet and others.

washed away by the discharge, or make their escape unnoticed before becoming sufficiently developed to call forth any marked symptoms of their presence. In investigating this subject it is of especial interest to determine the manner of the deposit of the eggs or larvæ, the conditions necessary to their development, and the manner in which they maintain their lodgment within the ear despite vigorous attempts at their removal, together with the symptoms which indicate their presence.

In three out of the four cases which have come under my observation the larvæ were extracted alive and preserved for further study. In these three cases two were larvæ of muscida sarcophaga, and one of m. lucilia. From the description given of the larvæ in the fourth case, I suppose it to have belonged to the latter family. In every case there was an otitis media purulenta, with extensive destruction of the membrana tympani, and profuse otorrhœa. The *symptoms indicating the presence of the larvæ* were increasing deep-seated pain, which, within twenty-four hours, became almost intolerable, accompanied by a sensation as of something moving within the ear; within twenty-four hours also from the commencement of the pain the discharge increased in quantity, and became streaked with blood. In both cases of the deposit by m. sarcophaga the larvæ were visible as a whitish undulating mass, filling the middle ear and inner end of the meatus, and were extracted singly by means of the probe or forceps, it being impossible to remove them, even by forcible syringing. From

the first of these cases five, and from the second four larvæ were removed. In each of the remaining cases but a single larva of m. lucilia was found.

With the removal of the larvæ the intense pain and the streaks of blood in the discharge ceased, and there remained only the original affection, with the increased inflammation resulting from the presence of the larvæ.

The sarcophaga and lucilia belong respectively to the classes of viviparous and oviparous muscidæ. In sarcophaga the eggs are hatched in large numbers within the body of the mother; and the larvæ, when born, are ready to begin the first stage of active existence, and seek food for themselves. The body of the larva is made up of a series of rings, constant in number, gradually increasing in size from the front backwards. Four of these rings may be said to constitute a long tapering head, armed with a pair of hard and sharp mandibles, projecting forwards and downwards.

At the birth of the larva it may be seen protruding for about half its length from the abdomen of the fly, and moving its head in search of something to which it may attach itself. Should a piece of meat or other such object be presented, the mandibles are driven into it, and the larva withdraws itself from the body of the mother, and is immediately followed by another and another, until several have been delivered.

The larvæ of lucilia are distinguishable from those of sarcophaga by the difference in the shape of the body, which is much more tapering, by the truncated posterior

extremity, which exhibits, moreover, but two spiracles in contrast to the three pair of allied larvæ, and by the arrangement of the papillæ, to be noticed further on. The head, like that of sarcophaga, is pointed, and has a pair of mandibles. The eggs of M. lucilia, which are deposited singly or in little heaps, are hatched generally within a day, under favorable circumstances of warmth and moisture within a few hours, after being deposited. On the breaking of the egg the larva attaches itself, as does that of m. sarcophaga, and, effecting its delivery, immediately begins feeding.

In m. sarcophaga, the birth of successive larvæ is effected with great rapidity, and several may be deposited in the space of a few seconds, while in m. lucilia, though several eggs may be laid, they are inert bodies, and might be easily washed away by the outpouring of a secretion so copious as that which sometimes flows from the ear. In this light we may be able to account for the fact that while several of the larvæ of m. sarcophaga were found where the deposit had been made by that fly, in the other two cases there were but single specimens of the larvæ of m. lucilia.

For purposes of observation a larva of m. sarcophaga, taken from the ear at a very early stage of development, as nearly as could be ascertained within twelve hours of the time of its deposit, was placed on the bottom of a thin beaker glass, and covered with a piece of raw beef, soaked in warm water, in such a manner as to bring the larva between the meat and the bot-

tom of the glass; the glass then being inverted, the movements of the larva could be easily studied under the microscope.

The apparatus by which the larva attaches itself, and which serves to pierce and tear the tissue in which it seeks to imbed itself, is made up of a strong but delicate frame-work of horny structure, of a color varying from a light brown to a deep brownish black, lying within the interior rings, and of two hooks or mandibles, also of a stout horny structure, and deep-black in color, articulating therewith.

Horny Frame-work and Mandibles of Larva of M. Sarcophaga, $\frac{40}{1}$.
a. Frame-work. *b.* mandible. *c.* articulation between mandible and frame-work. *d.* attachment of anterior ring. *e.* rim of flange turned downwards and broken away.

The frame-work is double, the two lateral halves being symmetrical, and connected by a dense rib or bridge below, and by a rounded flange above, convex on its upper surface. Viewed laterally, as shown in the engraving, we distinguish this flange above, at *e* the rim has been broken away and turned downwards, the flange narrows downwards to form a stout neck connecting it with the lower portion of the frame-work, which is made up of two arms terminating anteriorly in articular processes, which set into sockets at the bases of the mandibles. In the engraving but one mandible is seen.

The first ring encloses the posterior portion of the mandibles and the articulation, while the remainder of

the frame-work is usually situated within the second and third rings. The integument of the first ring is attached to the roots of the claws of the mandibles (as shown at *d*), so that of these latter only a portion is exposed, the remainder, together with the whole of the framework, being covered. When the body and head of the larva are extended, the mandibles are thrown upwards and forwards, the tension of the integument of the first ring attached around the roots of the claws, drawing the articulating surfaces together, and fixing the mandibles firmly in the extended position which is requisite for the purpose of piercing.

The second position of the mandibles, when they are used for tearing, is produced by a contraction of the inferior, and relaxation of the superior, surfaces of the rings, the mandibles being drawn downwards at an angle of about 45° to the long axis of the frame-work. It is by repeated extension and contraction of the mandibles, alternately piercing and tearing, that the larva burrows its way into the tissue on which it feeds, and which is to form the asylum for its future transformation.

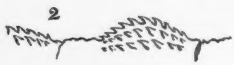


Fig. 1. Papillæ of larva of M. Sarcophaga.

Fig. 2. Papillæ of larva of M. Lucilia.

A microscopic examination of the integument of the larva shows a series of minute papillæ studding the surface of each ring; they gradually increase in size and number with the increase in size of the rings from the head

backwards, and at the termination of the last ring are represented by irregular rounded protuberances.

The papillæ in both sarcophaga and lucilia are in the form of cones, broad at the base, curving backwards as they ascend, and terminating in a sharp point directed outwards and backwards. They are very firm and serve an important purpose, both in aiding the movements of the larva within its burrow, and in connection with the operation of the mandibles. Their arrangement in the two species is somewhat different. In sarcophaga they cover almost the entire surface of each ring (see Fig. 1), while in lucilia they are smaller and set upon a ridge of firm elastic tissue which encircles the anterior portion of each ring (see Fig. 2).

In the operation of piercing, as has been said, the integument of the anterior rings is made tense, and the mandibles are thereby extended and fixed firmly upon the frame-work in that position. The anterior rings containing the framework are then retracted as a whole, and thrust quickly forward with a force often sufficient to bury the claws up to their roots. This movement is repeated with great rapidity, and simultaneously with each blow the body is dilated, and the sharp papillæ forced into the walls of the burrow, thus giving the necessary support. Preparatory to retreating from the burrow an undulatory movement is noticeable, the rings being rolled or drawn forward as if to withdraw the papillæ. Watching the larva in the beaker glass, we

see exemplified the facts that moisture, warmth, and air are absolutely necessary to its existence.

If the meat be allowed to become dry, the difficulty of piercing and tearing is proportionately increased when subjected to a gradually decreasing temperature, the larva becomes less and less active, while at about the temperature of the human body it works with great rapidity.

In burrowing, the posterior portion of the body, with the spiracles, is always exposed to the air, and should the burrow be filled with fluid, the larva hastily retreats to the surface.

In both sarcophaga and lucilia the mandibles are largely developed at an early stage of existence, but do not increase proportionately with the growth of the larvæ.

They are at all stages very formidable in proportion to the size of the body, and this, together with their shape and the method in which we have seen them to be employed, accounts for the pain accompanying their presence within the ear, and for the blood appearing in the discharge previous to their removal, and explains the tenacity with which they cling to the surface to which they have attached themselves.

That they should be found most frequently at the inner end of the meatus and within the middle ear is not singular, when we consider that the instinct of the larva is to bury itself below the surface, and to seek warmth, moisture, and a soft yielding tissue for its operations.

AN INVESTIGATION CONCERNING THE MECHANISM OF THE OSSICLES OF HEARING, AND THE MEMBRANE OF THE ROUND WINDOW.

By CHARLES H. BURNETT, M.D.,

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The theories of Edward Weber,* and those of Helmholtz,† concerning the mechanism of the ossicula auditûs, have led most physiologists of the present day to the conclusion that the chain of ossicles move as a lever, and thus communicate their motion to the labyrinthine fluid.

The movements of these bones, in connection with sound-waves, have been observed, and their excursions measured by Buck.‡

The aim of this investigation, however, has been to observe the condition of the membrana tympani secundaria during the action of the ossicles of hearing, and to measure the excursions performed by it.

At the same time attention has been given to the

* Bericht über die Verhandlungen der königl. sächs. Gesellschaft der Wissenschaften zu Leipsic, 1851.

† Pflüger's Archiv für Physiologie. 1. Jahrgang.

‡ Archives of Ophthalmology and Otology. Vol. I. 1870.

effect of altered labyrinthine pressure upon the chain of bones and the membrane of the round window.

The experiments were made in the Physical Institute of the University of Berlin, at the suggestion and with the aid of Prof. Helmholtz, to whom I owe my most cordial thanks for his constant readiness to assist, and the deep interest he has taken in the proper completion of the work.

The observations were made upon temporal bones taken from human subjects, as soon as possible after death.

If they were laid aside before the examination was complete, they were preserved in 10 per cent. solution of alcohol. This weak preservative fluid prevents any stiffening or hardening effects, so common to the ordinary alcoholic solution. The sex and the age of each preparation is shown in the following table:—

Preparation.	Age.	Sex.
I.	6.	Male.
II.	17.	Female.
III.	32.	Male.
IV.	45.	Male.
V.	20.	Male.
VI.	18.	Male.
VII.	28.	Male.
VIII.	25.	Female.
IX.	30.	Male.
X.	25.	Male.

The Eustachian tube was removed, but the membrana

tympani, with the annulus tympanicus, the chain of ossicles and the labyrinth, were left entirely intact.

In order to obtain the best view of the fenestra rotunda, the floor of the tympanum was removed as high as the round window, till it and the promontorium cochleæ were fully exposed. The chief difficulty experienced in thus exposing the round window is the liability to encroach upon the posterior semicircular canal.

To avoid this, a view of the window was first gained, by cautiously chiselling away the posterior portion of the floor of the tympanum, and then turning the entire preparation forwards upon an axis running through the porus acusticus and the auditory meatus.

Then the bone may be chiselled away in all directions, excepting outwards and upwards, till a perfect view of the round window is obtained.

The preparation was then fastened firmly in a vice, and laid so as to be conveniently approached by a microscope, and to receive, by means of a condenser, light from a kerosene lamp. The preparation now lay so as to expose the chain of ossicles from underneath, and the membrana tympani secundaria, at an angle of circa 45°. These were sprinkled lightly with powdered amylum, which insures bright vibrating points.

Sources of Sound.—Method of Conduction to the Preparations.—Results of the Experiments.

As sources of sound, four organ-pipes were used respectively of 50, 140, 630, 1160 vibrations per second.

The first was a reed-pipe, the three remaining ones were stopped pipes. These were connected with the ear, in each case, by means of a gutta-percha tube 1 metre long and $\frac{1}{2}$ cm. wide, fastened to the side of the reed-pipe; but in the case of the other three, at the closed end.

The free end of the connecting gutta-percha tube was supplied with a tapering glass tube, pointed with sealing-wax, moulded to the external auditory meatus, thus procuring an air-tight communication between the organ-pipe and the membrana tympani. All unwished-for vibrations were avoided by placing the pipes upon separate tables, and in some instances they were held in the hand during the occurrence of a note. This necessitated all vibrations which reached the ear to pass through the connecting-pipe.

The position of the glass tube in the external auditory meatus has great influence on the experiments. When the tube is directed downwards and forwards the experiments are almost invariably successful, but in any other position they may be partially or entirely unsatisfactory.

For, in the former position, the sound waves strike directly against the membrana tympani and the hammer, whereas in any other position they are forced against the sides of the auditory canal, and are deflected and destroyed before they reach their destination. This seems to indicate that sound, entering the external auditory meatus, produces no distinguishable effect upon the ossicles of hearing and the labyrinth by simple con-

duction through the bony walls of the auditory canal. It must, indeed, be forced against the membrana tympani, and through it act upon the ossicula auditus. These, in turn, act like a lever, which communicates its movements to the fluid of the labyrinth and the membrane of the round window.

Upon producing a note upon a given pipe connected with the ear, as already described, the chain of bones was seen to vibrate in excursions, bearing a fixed relation to each other. At the same time their motion was communicated through the labyrinth to the membrane of the round window, upon which the excursions of the points of light maintained an almost constant relation of equality with those of the stapes.

The excursions, both upon the chain of ossicles and upon the membrane of the round window, varied in their length with the pitch of note produced by the pipe; the longer excursion corresponding to the deeper note, as may be seen in the annexed tables.

By the use of the sirene, which was fitted to a pipe opened at its side to accommodate the gutta-percha connecting tube, excursions synchronous with the revolutions of the disc were produced upon the chain of ossicles and the membrane of the round window. These could be counted during the early revolutions of the disc; but as they increased and the note ascended, the excursions became lines diminishing in length with the increasing rapidity of the revolution.

During these observations one preparation was found

which did not respond to the notes on the pipes as the previous ones had done. The ossicula auditus manifested some very slight vibratory motions, but the membrane of the round window showed none.

In order to explain this apparently abnormal result, and to find out whether an increased or diminished labyrinthine pressure could have produced it, the following experiments were instituted :—

3. *Labyrinthine Pressure.—A Method of its Artificial Production.*

Upon a perfect petrous bone, which failed to respond to the sounds produced by the already-mentioned pipes, the superior semicircular canal was opened at its summit, and to this opening one end of a small glass tube, 1 centimetre long by 5 mm. wide, was hermetically sealed. The bone thus modified was placed in water and brought under the air-pump, in order to remove any air which might have entered the labyrinth. After all these manipulations the glass tube, sealed to the superior semicircular canal, was connected by a gutta-percha tube, of similar diameter, to a reservoir of water, consisting of a funnel placed in a retort-holder, and which could be elevated or depressed at will.

The pressure exercised by the water upon the labyrinth could be easily seen with the unaided eye, as the varying height of the funnel caused the column of water to press with a greater or less force upon the membrane of the round window.

With these modifications the preparation, which formerly failed to respond to the notes of the organ-pipes, was placed in connection with the sources of sound, and the chain of bones, as well as the membrane of the round window, were observed during the passage of a note to the ear.

The desired excursions now became apparent upon the hitherto inadequate preparation, and resembled those upon other preparations so long as the pressure was maintained at a certain grade; but when increased or diminished beyond a given point, the excursions ceased both upon the ossicles and the membrane of the round window. And this was observed to be the case sooner during the occurrence of a high note than of low and powerful notes.

Preparation No. V., in connection with the pipe of 140 vibrations per second, shows the result of labyrinthine pressure at and above a desirable point.

In its unmodified state the pressure was insufficient to produce a response to waves of sound which acted upon the membrana tympani.

The same may be said of Preparation VI., with pipe of 630 vibrations per second.

Preparation VIII., with the same pipe, shows the result of increasing labyrinthine pressure.

Preparation IV., with pipe of 1,160 vibrations per second, compared with its action when connected with pipe of 50 vibrations per second, shows the advantage of low notes over high notes in cases where the intra-

aural pressure is increased. However, a certain degree of pressure within the labyrinth is necessary for the production of excursions upon the membrane of the round window. This is seen by referring to Preparations V., VI., and VII., in connection with pipe of 50 vibrations per second. Also in the case of Preparation V., in connection with pipe of 140 vibrations per second.

The human ear, in the living state, sometimes fails to perceive high notes, while lower ones are distinctly heard.

Perhaps such phenomena may be explained by an application of the results obtained in these investigations, in which artificial intra-aural pressure interfered with the action of the chain of ossicles and the membrane of the round window, sooner in connection with high notes than with lower ones. Pathological processes, with results of a purulent,* serous, or hemorrhagic † nature, have been observed, and their injurious effects upon the sense of hearing noted.

In such cases it may be supposed that the increased amount of fluids operated upon the labyrinth, and interfered with the action of the chain of bones and the membrane of the round window, just as the artificial pressure in the cases already tabulated.

In addition to these destructive changes, which follow acute local pathological processes, the perilymph of the

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* See Moos' Deafness in Meningitis Cerebrospinalis. Archives of Ophthalmol. and Otol. Vol. I., No. 2. 1870.

† Moos' Four Cases of Gunshot Wounds of the Ear. Vol. II., p. 343, etc., of hese Archives.

labyrinth may be subject to great fluctuations in its amount, if the arachnoidal sac and the cochlea are so intimately connected, as experiments of F. E. Weber* seem to indicate.

In concluding this article I would call attention to a fact of interest respecting the direction of a line described by a vibrating amylum-point upon the membrane of the round window. It was observed that such a line invariably remained parallel to the plane of the membrana tympani.

An explanation may be found in ultimately discovering an unequal tension of the membrana tympani secundaria, dependent upon the manner of its insertion into its frame.

The following deductions may be drawn from the foregoing experiments:—

1. The excursions of the chain of ossicles of hearing bear a fixed relation to each other.

2. The excursions of the ossicles of hearing are communicated through the labyrinthine fluid to the membrane of the round window.

3. The excursion of the membrane of the round window generally equals that of the stapes; but it may equal that of the membrana tympani,† at the point of the manubrium mallei.

4. The pressure within the labyrinth, increased beyond

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* Monatsschrift für Ohrenheilkunde. Berlin. 1870. August.

† Compare Preparation X., normal condition, connected with pipe of 140 vibrations per sec.

certain limits, causes cessation of the action of the membrane of the round window and the chain of ossicles of hearing. This occurs sooner in connection with high notes than with the lower notes of the scale.

5. If the labyrinthine pressure is greatly diminished or totally removed, the chain of ossicles may continue to vibrate, but they exert no influence upon the membrane of the round window.

HEIDELBERG, October 1st, 1871.

TABULAR VIEW OF THE RESULTS OF THE EXPERIMENTS.

A.—*Excursions produced by Pipe of* 50 *Vibrations per Second.*

CONDITION OF THE PREPARATION.	Excursions at the point of the long process of the hammer.	At the point of the long process of the incus.	At the head of the stapes underneath.	Upon the membrane of the round window.
PREPARATION I.				
Natural state	0.080 mm.	0.048 mm.	0.032 mm.	0.032 mm.
Pressure $\frac{1}{10}$ atmosphere	0.032 mm.	0.008 mm.	0.008 mm.	0.008 mm.
" $\frac{1}{5}$ "	0.016 mm.	0.016 mm.	0.008 mm.	0.008 mm.
PREPARATION II.				
Natural condition	0.064 mm.	0.032 mm.	0.032 mm.	0.032 mm.
PREPARATION IV.				
Natural condition	0.064 mm.	0.016 mm.	0.016 mm.	0.016 mm.
Pressure $\frac{1}{20}$ atmosphere	0.048 mm.	0.016 mm.	0.016 mm.	0.016 mm.
" $\frac{1}{10}$ "	0.032 mm.	0.008 mm.	0.008 mm.	0.008 mm.
" $\frac{1}{5}$ "	0.016 mm.	0.016 mm.	0.016 mm.	none.
" $\frac{1}{90}$ "	0.032 mm.	0.016 mm.	0.016 mm.	0.016 mm.
PREPARATION V.				
Natural condition	0.008 mm.	0.004 mm.	0.004 mm.	
Pressure $\frac{1}{20}$ atmosphere	0.032 mm.	0.016 mm.	0.016 mm.	0.016 mm.
PREPARATION VI.				
Natural condition	0.016 mm.	0.008 mm.	0.008 mm.	0.008 mm.
Pressure $\frac{1}{90}$ atmosphere	0.064 mm.	0.032 mm.	0.032 mm.	0.032 mm.
PREPARATION VII.				
Natural condition	0.016 mm.	0.008 mm.	0.008 mm.	0.008 mm.
Pressure $\frac{1}{60}$ atmosphere	0.008 mm.	0.002 mm.	0.002 mm.	0.002 mm.
PREPARATION VIII.				
Natural condition	0.048 mm.	0.032 mm.	0.032 mm.	0.032 mm.
Pressure $\frac{1}{60}$ atmosphere	0.032 mm.	0.032 mm.	0.016 mm.	0.016 mm.
" $\frac{1}{30}$ "	0.016 mm.	0.016 mm.	0.008 mm.	0.008 mm.

B.—*Excursions produced by the Pipe of* 140 *Vibrations per Second.*

Preparation I.

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the incus.	At the head of the stapes underneath.	Upon the membrane of the round window.
Natural condition	0.064 mm.	0.032 mm.	0.032 mm.	0.032 mm.
Pressure $\frac{1}{20}$ atmosphere	0.064 mm.	0.016 mm.	0.016 mm.	0.016 mm.
" $\frac{1}{10}$ "	0.032 mm.	0.008 mm.	ceased.	ceased.

Preparation II.

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the incus.	At the head of the stapes underneath.	Upon the membrane of the round window.
Natural condition	0.048 mm.	0.016 mm.	0.016 mm.	0.008 mm.

Preparation III.

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the incus.	At the head of the stapes underneath.	Upon the membrane of the round window.
Natural condition	0.080 mm.	0.032 mm.	0.032 mm.	0.016 mm.

Preparation IV.

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the incus.	At the head of the stapes underneath.	Upon the membrane of the round window.
Natural condition	0.080 mm.	0.032 mm.	0.024 mm.	0.024 mm.
Pressure $\frac{1}{20}$ atmosphere	0.048 mm.	0.008 mm.	0.008 mm.	0.008 mm.
" $\frac{1}{10}$ "	0.032 mm.	ceased.	ceased.	ceased.

Preparation V.

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the incus.	At the head of the stapes underneath.	Upon the membrane of the round window.
Natural condition	0.048 mm.	0.	0.	0.
Pressure $\frac{1}{20}$ atmosphere	0.032 mm.	0.008 mm.	0.008 mm.	0.008 mm.
" $\frac{1}{10}$ "	0.024 mm.	0.006 mm.	0.006 mm.	0.004 mm.

Preparation VI.

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the incus.	At the head of the stapes underneath.	Upon the membrane of the round window.
Natural condition	0.032 mm.	0.016 mm.	0.016 mm.	0.016 mm.
Pressure $\frac{1}{90}$ atmosphere	0.032 mm.	0.016 mm.	0.016 mm.	ceased.
" $\frac{1}{30}$ "	0.016 mm.	0.008 mm.	ceased.	ceased.

Preparation VII.

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the incus.	At the head of the stapes underneath.	Upon the membrane of the round window.
Natural condition	0.016 mm.	0.008 mm.	0.008 mm.	0.008 mm.
Pressure $\frac{1}{90}$ atmosphere	0.032 mm.	0.008 mm.	0.008 mm.	ceased.

Preparation VIII.

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the incus.	At the head of the stapes underneath.	Upon the membrane of the round window.
Natural condition	0.032 mm.	0.016 mm.	0.016 mm.	0.016 mm.
Pressure $\frac{1}{90}$ atmosphere	0.032 mm.	0.008 mm.	0.008 mm.	
" $\frac{1}{30}$ "	0.016 mm.	0.008 mm.	0.004 mm.	

Preparation IX.

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the incus.	At the head of the stapes underneath.	Upon the membrane of the round window.
Natural condition	0.032 mm.	0.008 mm.	0.008 mm.	0.008 mm.
Open to the air	0.080 mm.	0.032 mm.	0.032 mm.	0.004 mm.
Pressure $\frac{1}{30}$ atmosphere	0.016 mm.	0.005 mm.	0.005 mm.	
" $\frac{1}{10}$ "	0.008 mm.			
" $\frac{1}{5}$ "	0.005 mm.			

Preparation X.

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the incus.	At the head of the stapes underneath.	Upon the membrane of the round window.
Natural condition	0.048 mm.	0.016 mm.	0.016 mm.	0.048 mm.
Open to the air—fluid in the labyrinth	0.064 mm.	0.032 mm.	0.032 mm.	0.032 mm.
Open to air—no fluid in the labyrinth	0.016 mm.			

C.—*Excursions produced by the Pipe of* 630 *Vibrations per Second.*

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the anvil.	At the head of the stirrup underneath.	Upon the membrane of the round window.
Preparation IV.				
Natural condition	0.008 mm.	0.004 mm.		
Pressure $\frac{1}{10}$ atmosphere	0.008 mm.	0.004 mm.	0.004 mm.	0.004 mm.
Preparation VI.				
Natural condition	0.	0.	0.	0.
Pressure $\frac{1}{60}$ atmosphere	0.008 mm.	0.008 mm.	0.004 mm.	
" $\frac{1}{30}$ "	0.004 mm.	0.002 mm.	0.002 mm.	
Preparation VII.				
Natural condition	0.008 mm.	0.004 mm.	0.004 mm.	
Pressure $\frac{1}{90}$ atmosphere	0.048 mm.	0.032 mm.	0.016 mm.	0.016 mm.
Preparation VIII.				
Natural condition	0.032 mm.	0.016 mm.	0.016 mm.	0.016 mm.
Pressure $\frac{1}{90}$ atmosphere	0.016 mm.	0.016 mm.		
" $\frac{1}{30}$ "	0.048 mm.	0.016 mm.	0.016 mm.	
" $\frac{1}{10}$ "	0.032 mm.	0.008 mm.	0.008 mm.	
Preparation IX.				
Natural condition	0.016 mm.	0.008 mm.	0.008 mm.	0.008 mm.
Pressure $\frac{1}{30}$ atmosphere	0.032 mm.	0.008 mm.	0.004 mm.	
Open to air—some fluid remaining in labyrinth	0.080 mm.	0.032 mm.	0.016 mm.	0.004 mm.
Preparation X.				
Natural condition	0.032 mm.	0.016 mm.	0.016 mm.	0.032 mm.
Open to air	0.064 mm.	0.032 mm.	0.032 mm.	0.032 mm.
Labyrinth open and empty	0.032 mm.	0.016 mm.	0.008 mm.	

D.—*Excursions produced by the Pipe of* 1,160 *Vibrations per Second.*

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the anvil.	At the head of the stirrup underneath.	Upon the membrane of the round window.
Preparation IV.				
Natural condition	slight motion.	none.	none.	none.
Pressure $\frac{1}{90}$ atmosphere	0.016 mm.	0.008 mm.	0.008 mm.	0.004 mm.
" $\frac{1}{20}$ "	0.008 mm.	0.004 mm.	0.004 mm.	not percept'le
Preparation VI.				
Natural condition	no motion.	none.	none.	none.
Pressure $\frac{1}{90}$ atmosphere	0.006 mm.	0.002 mm.	0.002 mm.	0.002 mm.
" $\frac{1}{30}$ "	0.002 mm.	0.001 mm.	0.001 mm.	not percept'le
" $\frac{1}{10}$ "	slight motion.	none.	none.	none.
Preparation VII.				
Natural condition	0.001 mm.	none.	none.	none.
Pressure $\frac{1}{30}$ atmosphere	0.008 mm.	0.004 mm.	none.	none.

Condition of the Preparation.	Excursions at the point of the long process of the hammer.	At the point of the long process of the anvil.	At the head of the stirrup underneath.	Upon the membrane of the round window.
Preparation VIII.				
Natural condition	0.004 mm.	0.002 mm.	0.002 mm.	0.002 mm.
Pressure $\frac{1}{30}$ atmosphere	0.002 mm.	none.	none.	none.
Preparation IX.				
Natural condition	0.008 mm.	0.002 mm.	0.002 mm.	0.002 mm.
Labyrinth open to air	0.004 mm.	0.002 mm.	0.002 mm.	none.
Preparation X.				
Natural condition	0.002 mm.	0.001 mm.	0.001 mm.	0.001 mm.
Labyrinth open to air	All ceased.	ceased.	ceased.	ceased.

LIGATION OF THE COMMON CAROTID ARTERY, AFTER A GUN-SHOT WOUND, ON ACCOUNT OF COPIOUS HEMORRHAGE.

TINNITUS AURIUM AND DEAFNESS—DIAGNOSIS OF THE POSITION OF THE BALL FROM THE CONDITION OF THE EAR—ACOUSTIC AND PHYSIOLOGICAL REMARKS.

By Dr. OSCAR WOLF,

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Translated by Dr. C. H. Burnett, of Philadelphia.

Although every case of ligation of the common carotid artery is of interest to the physiologist as well as to the surgeon, I consider the present case, nevertheless, as especially worthy of mention in these Archives, because it offers at once many explanations of the acoustic and physiological functions of the middle and inner ear.

Post-office assistant and subaltern officer G. was severely wounded at Sedan, on the 1st Sept., 1870. The Chassepot-ball entered the right cheek under the zygomatic arch. The track of the ball ran almost horizontally, and at right angles to the sagittal plane of the head, through the superior maxillary bone. It remained impacted in the head of the patient, and its position could not be determined. The hemorrhage, at the time of the reception of the wound, was moderate, and the patient remained unconscious for several minutes, but

recovered so well after two days had elapsed that he was transported to Aix-la-Chapelle, where he arrived on the 7th Sept. The first stage of the wound and its appearance offered nothing worthy of remark.

On the 12th Sept., G. came to Frankfort, and entered upon the duties of private life, and as a member of a reserve corps was really no longer under medical care. As a result of the wound, the movement of the under jaw was limited to a separation of ½″ of one row of teeth from the other. The sinus was almost closed, but discharged still a little pus. Upon the 15th October, six weeks after the reception of the wound, while G. was sitting at his beer, the first copious hemorrhage through the nose occurred. It lasted three-quarters of an hour, and stopped of its own accord.

On the 17th October, another hemorrhage occurred, which ended in syncope. When, upon the 20th Oct., another bleeding occurred, Dr. Getz was summoned, who quelled the hemorrhage by plugging the nostrils. On the 25th and 26th Oct., others occurred, which so exhausted the patient that he was brought in an unconscious condition to the hospital in the old Electoral Villa. Although the tampon applied to the nostrils could not be properly adjusted, on account of the impaired motion of the inferior maxillary bone, the hemorrhage soon ceased. The patient, however, was so anæmic that it was decided, upon the occurrence of another hemorrhage, to immediately undertake the ligation of the *right common carotid artery*.

The probe which was introduced into the sinus of the wound passed through it, and came at last into a larger cavity (the naso-pharyngeal space?), without being able to determine the seat of the ball, which was supposed to be the cause of the hemorrhages.

Upon the 6th of November, at the occurrence of another hemorrhage, Dr. Getz proceeded immediately to ligate the common carotid artery upon the right side. The superficial incision was nine centimetres long, and ran upwards and to the right, from the centre of the superior border of the sternum towards the anterior edge of the sterno-cleidomastoid muscle. The vein was quite rapidly isolated, and the entire operation completed in fifteen minutes. The epistaxis ceased instantly.

Since, on account of the weakness of the patient, the operation was performed without the use of an anæsthetic, he was able, immediately after the ligation was completed, to give me a distinct and perfect account of his *subjective sensations* in each moment of its performance, and I shall discuss these further on, under the head of physiological observations.

The course of the wound caused by the operation was very favorable, and the reaction very slight. The ligature fell upon the eighth day; no more hemorrhages occurred, the patient grew stronger each day, and by the beginning of February the incision upon the throat had cicatrized. The most important disturbance of which G. complained was an intense and annoying humming in the ear, connected with deafness. This was

not in connection with the right side, upon which the ligation of the carotid had been performed, but in the left ear. Upon a closer questioning of the patient, I found, however, that this humming in his ear and the deafness had in no way been due to the ligation of the carotid, but had been present since the reception of the wound at Sedan; that it had in the first few days subsequent to the wound considerably increased, and had continued, without intermission, both day and night. The description which the patient gave me of these subjective sounds was important and interesting. He distinguished a humming and buzzing composed of a number of notes lying very close to each other in the scale, as well as a blowing noise synchronous with the pulse. The latter considerably increased immediately after the ligation of the carotid. Before he was wounded, G. experienced nothing abnormal in his ears, and at the present time the right ear is entirely normal in all its functions. The testing of the hearing distance with the tuning-forks C° and A′ gives the following results:

When heard through the medium of the external auditory meatus, the notes of both forks were perceived normally by the *right ear*, but by the *left ear one-fifth higher*. When placed upon the head, the notes of the tuning-forks were heard by the left ear, considerably increased in intensity, but not any higher in pitch.

The left ear is impaired in ability to hear speech and the watch. The ticking of the watch is not heard at all;

loudly spoken sentences are heard only at the distance of 12′, and whispering only within ½′ of the ear.

Upon inspection, the left membrana tympani presents the characteristic picture which one generally finds where the tuba Eustachii has been closed for some time.*

The membrane itself was bright but reddishly translucent, probably from the great hyperæmia of the mucous membrane of the tympanum. I now introduced a hard rubber catheter into the left inferior nostril, found readily the pharyngeal opening of the tuba, and felt distinctly its prominent mouth. The catheter lay well and firmly in the tuba; but when I forced air into it none passed into the tympanum; on the contrary, I heard the air stream back into the naso-pharyngeal space. The position of the membrana tympani remained drawn in as before. A probe introduced through the catheter struck upon a firm and resisting body in the middle of the tuba. The examinations, which were repeated upon several following days, gave constantly the same results,—it was impossible to force air into the cavity of the tympanum. The middle portion of the left Eustachian tube was completely closed.

* Since, as is well known, the air within the cavity of the tympanum, in a normal condition of the Eustachian tube, is renewed at each act of swallowing, it is evident that this renewal cannot take place if the tube is hermetically closed. In such instances, within the tympanum, which is now shut off from the outer atmosphere, the small amount of air is soon absorbed, a partial vacuum formed, and the outer air presses the membrana tympani inwards. Hence the handle of the hammer appears shortened, the short process more prominent, and the pyramid of light broken.

From all these facts taken together, I could with great certainty suppose that the ball was firmly impacted in the region of the left Eustachian tube, and had completely closed its passage. The direction of the track of the ball corresponded also with this supposition. After this diagnosis it was resolved, at a meeting of the "Surgical Society," "to desist from all further attempts to extract the ball."

On the 3d March, six months after G. had been wounded, I performed paracentesis of the left membrana tympani, in order that the entrance of the outer air might restore the equilibrium in the sound-conducting apparatus, and hence the intra-aural pressure be diminished. I made a cruciform incision in the posterior inferior quadrant of the membrane, which was followed by a drop of blood and very slight pain. The instantaneous result of the operation was very striking; for the change in the curve of the membrane was distinctly visible, the short process of the hammer became less prominent, the two folds above it became smooth, and the handle of the hammer appeared to stand more vertically. The improvement in the hearing was very striking.

Previously the patient could not hear the ticking of the watch when placed upon the auricle, loudly spoken words only within 10′, whispering only within half a foot. Eighteen minutes after the operation he heard whispering at a distance of 15′, and the ticking of a watch at 3″. I now catheterized again the left Eustachian tube; but, as might have been supposed, no air came

from the tympanum, and yet had any air issued from the tympanum its hissing noise might have been all the more distinctly heard through the perforation.

By the next day the hearing had still improved, and whispering was heard at 28′, the ticking of the watch at 4″—from the ear. The pulsating noise in the ear still continued, but had become weaker, and the general humming had entirely ceased. Eighteen days later I saw the patient again; his left membrana tympani was again drawn inwards, just as it was before the paracentesis, and the perforation had healed. The hearing distance has receded to the limits it possessed before the paracentesis, and showed for the ticking of the watch 1″, and for whispering 6′. The general humming noise, together with the pulsating noise, had returned in all their previous intensity. For the relief of the patient I undertook a second time to perform paracentesis of the membrana tympani, making a much larger incision than in the first instance. Again the instantaneous improvement in the hearing distance and cessation of old humming sounds occurred. However, quite a painful inflammation of the tympanic membrane occurred, accompanied by inflammation of the bony portion of the external auditory canal. And after these had disappeared the incision in the membrana tympani had again healed.

At the present date, nine months after the injury, the condition remains the same; the humming as well as the pulsating noise have remained constant, but the hearing distance is better than it was before the first paracente-

sis. The condition of the left tuba is unaltered; G. perceives another annoyance from the presence of the ball and pursues his business undisturbed. His general condition is good, and only during some of the warm and sultry days of summer has he experienced pain in the region of the occipital bone, accompanied by a sensation of fulness in the head. I now determined to desist from all other attempts to maintain a constant opening in the membrana tympani, and that for the following reasons: On the supposition that it would be possible to keep the perforation open in the membrana tympani, it could only be accomplished by the excision of almost a quarter of the membrane. In every probability an inflammation of the tympanum would have followed such an operation, and as it would have been impossible to properly cleanse the middle ear, from the purulent matter, I was unwilling to expose one who had just recovered from an operation for ligation of the carotid artery to the dangers of purulent inflammation and pyæmia.

Physiological Remarks.

The case which has just been described shows:

1.) That the common carotid artery can be ligated without, in any important way, interfering with the functions of the central nervous system. During the operation G. was entirely conscious, perceived no pain in his head; his mind has been in no way affected, and he has been entirely able to fulfil his duties in the post-office department. At no time have symptoms of para-

lysis presented themselves. As has already been stated, only on some of the warm and sultry summer days has he experienced palpitation of the heart, fulness in the head, and pain in the region of the occipital bone. The ligation of the common carotid artery on the right side, and the consequent instantaneous interruption of the circulation in the petrous bone and the large arteries in its neighborhood, had in no way exerted any influence, either upon the functions of the right ear, nor had produced in it any subjective sensations; for G. perceived nothing different in the right ear, after the ligation, *i. e.*, his *right* ear remained both subjectively and objectively unchanged by the results of the ligation.

2.) Hemorrhages, occurring so late after the reception of a gunshot wound and when the sinus has almost healed, and yet not caused by the unremoved projectile, are rare, and their causes are most difficult to discover. We now know that the ball is impacted firmly in the left tuba, but the hemorrhage ceased immediately after the ligation of the right common carotid artery; hence the bullet could not have been the direct cause of the hemorrhage.

The explanation of this I accidentally discovered. One day G. told me, just before the first hemorrhage, six weeks after the reception of the wound, he heard "a crack" in his right upper jaw; and some time after that the sinus, which had almost healed, opened, discharging several splinters of bone, among which was a very sharp one. The loosening and discharge of this sharp piece of

bone, which had severed one of the larger arteries, was really the cause of the hemorrhage.

Acoustic and Physiological Observations.

This case offers many interesting explanations and suggestions, both for the theories of the conduction of sound and the subjective perception of sound, as well as for intra-aural pressure.

1.) At that point where I alluded to the tests with the tuning-forks, we noticed that the notes of both the forks C^{o} and A' appeared one-fifth higher when heard by the left ear than when heard by the normal right ear of the patient.

This observation was made by the patient himself without any suggestion on my part; and he sang quite correctly the *fifth* of the two forks as I placed them, one after another, to his ear. In my Acoustic Physiological and Pathological Studies * I have proven by example how we may explain this manifestation. Notes, when passing through a membrane, become higher in pitch, if the tension of the membrane is increased.

I have already shown that, in the case of our patient, the membrana tympani is in an abnormally increased degree of tension; and I here add another example by way of further illustration. A teacher in B. consulted me a few weeks ago especially, because he was temporarily unable to tune his violin with the fork A'. I found his left ear, in consequence of a severe illness in child-

* Sprache und Ohr, 1871, page 196.

hood, quite deaf; the right membrana tympani was drawn strongly inwards and abnormally stretched, while in the antero-inferior quadrant I discovered a deeply-sunken atrophic spot; the tuba was filled up in consequence of an acute attack of naso-pharyngeal catarrh. The patient heard the note of my tuning-fork A′ a third higher; and in addition, the general hearing distance of the right ear was considerably reduced for speech and the watch.

After opening the tuba by means of the air-douche and equalization of the atmospheric pressure within the tympanum, and reduction of the tension of the membrana tympani, the patient heard both speech and watch at almost the normal distance. The note of the tuning-fork A′ appeared to him quite plain, and he was able once more to correctly tune his violin. From time to time this disturbance returns, but the hearing is always restored by the use of the air-douche.

2.) Since it is impossible to give, at this point, a complete treatise upon the theories of *intra-aural pressure* and *subjective perception* of sound, I must confine myself to the consideration of a few points, which perhaps will help to simplify the comprehension of this difficult portion of physiological acoustics. In my book,* already alluded to, I have discussed the various grades of intra-aural pressure, in so far as they are influenced by the stapes.

In order that the sound-perceiving apparatus may nor-

* L. c., page 226

mally receive the waves of sound brought to it through the chain of ossicles and the oval window, it is necessary that the labyrinthine fluid, viz., the fluid which surrounds the terminal expansion of the acoustic nerve should place the individual nerve-fibres in a certain condition of excitement, by means of a varying pressure. If this pressure, exercised by the labyrinthine fluid, becomes at any time abnormally increased, we find that hyperæsthesiæ of the fibres of the acoustic nerve ensue, and reflex symptoms in the form of subjective sounds occur, which have been, until the present time, improperly termed "humming." (Sausen.)

Intra-aural pressure can be increased abnormally.

a.) When the membrana tympani and the chain of ossicles are pressed too forcibly inward, and thereby the base of the stirrup made to force the oval window too strongly inward.

b.) When exudations which have formed in the tympanum, cover both the windows of the labyrinth and press them inwards.

c.) When extravasations or new formations (for example osteophytic growths) arise which compromise the labyrinthine fluid.

d.) And when the arterial pressure of the entire body, and with it that of the intra-aural vessels, is abnormally augmented, so that at every systole the labyrinthine water is more powerfully compressed—for example, in the event of very great physical exertion, hypertrophy and valvular disease of the heart.

The effects of abnormally increased intra-aural pressure upon the central nervous system, which manifest themselves by vertigo, headache, especially frontal headache, nausea, and vomiting, are so well known that I may pass over them, alluding especially to only one reflex symptom, the so-called "humming." (Sausen.)

The case before us furnishes an instructive example of the analysis of subjective sounds in the ear, and every aural surgeon should in the future examine a patient, who complains of unpleasant noises in the ear, very carefully, respecting their acoustic character, viz.: their Pitch, Intensity, Duration, and Intermission. In that event we shall not only arrive sooner at a differential diagnosis, between affections of the middle ear and labyrinth, but also determine the nature and extent of the different affections of the labyrinth, especially in our day, when the love and knowledge of music, even among the less educated, are wide-spread. Our patient, G., perceived distinctly two kinds of sound—a *deep, constant and general roaring*, and a noise synchronous with the pulse, of a blowing and intermittent nature, which I shall, for sake of brevity, denominate "pulse noise." (Pulsgeräusch.) The former is the result of the generally and abnormally increased pressure upon the fluid of the labyrinth, whereby many of the fibres of the acoustic nerve, which lie very near together in the scale in respect to their pitch, and which are similarly and simultaneously irritated, respond to a number of notes occurring at the same moment, and lying very close together

in the scale, and therefore not more accurately definable; the whole thus representing a dull volume of sound.*

This sensation of sound in the patient was due to the continued closure of tuba, and the excessive inward pressure of the chain of ossicles.

It ceased from that moment, when, after the paracentesis of the membrana tympani, the air entered the tympanum, the chain of ossicles receded and removed the pressure from the water of the labyrinth; of course, it must return as soon as the perforation is healed, and, on account of the exclusion of the outer atmosphere, the chain of ossicles again presses the oval window firmly inwards.

The "pulse noise" increased considerably after the ligation of the right carotid artery, because thereby the arterial pressure in the carotid of the other half of the body, after the operation, was quite abnormally increased. The paracentesis of the membrana tympani removed, 'tis true, temporarily, one of the causes of this noise—the abnormal intra-aural pressure exerted through the oval window—but the other cause, the abnormally increased pressure of blood after the ligation of the carotid, remained.

Consequently the "pulse noise" was weakened after the paracentesis, but did not entirely disappear. The "pulse noise" is the result chiefly of increased intra-aural "*blood pressure*" (Blutdruck); in a less degree it

* Compare the definition of noises (Geräusche) in my already mentioned book.

may be due to increased pressure on the labyrinth fluid, and need not necessarily be accompanied by any other sensations of sound. It often occurs in those of perfect hearing, and lasts sometimes for years, without any ground for supposing that a disease of the ear is present. We do not hear, as is well known, under ordinary circumstances, the tones of the larger vessels, which are found in and about the petrous bone; but we may perceive them artificially, and that by simply altering the resonance in the inner ear and the flow of sound from the ear.

If, for example, I lie down, placing my ear upon the pillow, I hear no arterial sound, but if I close my auricle upon the ext. auditory meatus, by which I alter the resonance of my ear, and at the same time give my head a certain position, I instantly hear the arterial sounds, which probably depend upon the pulsation of the carotid. The explanations of Mach and Politzer have, 'tis true, been greatly attacked, but it seems to me that the truth lies in a middle point, and that various causes, viz., altered conditions of resonance, increased intra-aural pressure, and diminished escape of sound, together, or each alone, may so operate, that notes or tones which occur in or upon our heads (as, for example, when tuning-forks are placed upon the head), in the above mentioned instances, are heard better by the affected ear. Heretofore we have endeavored to elucidate especially the origin and character of two kinds of sound sensations, the "general dull roaring" and the "pulse noise." There remain a few words to be added concerning the kinds

of sound sensations which generally occur without symptoms of increased pressure in the labyrinth water. These are:

Singing, Seething, Hissing, Ringing, and Whizzing. Hissing corresponds, when objectively produced, to a small number of very high notes, lying very near to each other in the scale, and therefore unharmonic. We find these in the sibilant S. Seething or simmering are produced by the passage of air-bubbles through hot water just before it boils. It represents also a certain number of high notes, and in the diseased auditory apparatus corresponds to an isolated irritation or hyperæsthesia of affected and neighboring fibres of Corti.

Ringing, or the sound of bells or of pipes, is rather the term for non-composites or simple tones, as, for instance, those of the flute. It shows that single fibres are affected, and may occur as a consonating or resonating sound, whenever the corresponding notes are produced, objectively, in the proximity of the affected individual.

3.) How long an abnormally increased intra-aural pressure can exist, without causing the auditory nerve to pass from a stage of hyperæsthesia to one of anæsthesia and paralysis, is, in some degree, demonstrated by the present case of closure of the tuba eustachii. The tuba of the patient G. had been hermetically closed for six months, without the occurrence of any organic disturbance in the sound-conducting or sound-perceiving apparatus; for, that the disturbances which have so far

arisen from the closure of the tuba, *i. e.*, diminution of the hearing distance and perception of sound, are purely *functional*, is manifest from the result of the first paracentesis of the membrana tympani, after which the hearing distance almost reached the normal standard, and the "humming" ceased. It therefore appears to me, in this case, that if the ball could have been removed, and the tuba again opened, the relaxation of the membrana tympani would have gradually disappeared, and the left ear again made normal.

If, in general, we have reason to conclude, from the nature of the subjective sensations already described, that only single fibres of Corti are affected, and not that the entire terminal expansion of the auditory nerve has first been in a state of hyperæsthesia, resulting in ultimate anæsthesia, we shall find, by testing the hearing in such cases with tuning-forks and the human voice, that deficiencies* in the perception of certain tones or entire series of notes exist, just as diseases of the posterior portion of the eye are accompanied by deficiencies in the field of vision. In conclusion, we will glance at the perception of sounds which may arise in the tympanum, and which therefore cannot be termed "subjective," because they are produced by real, objectively excited undulations. We do not perceive, as a rule, the noises caused by the entrance of air into the tympanum at the act of swallowing (muscular noises), or at least we do not notice them; upon pressing air into the tympanum,

* Tonlücken.

by the act of blowing the nose, or by the Valsalvian method, we do notice a "cracking" or "crackling" noise.

If serous fluid has collected in the tympanum, in abnormal amount, the passage of air through this produces a "gurgling," with a somewhat metallic timbre, similar to that produced by pouring fluid from a bottle. If the membrana tympani is perforated, a hissing sound is produced when the patient presses air through the tympanum. All of these sensations are transitory and unannoying; far more disagreeable are the muscular noises which depend upon the rapid and involuntary contractions of the tensor tympani, often lasting day and night, and characterized as a "lapping" or "snapping." I have seen three cases of this unusual condition (clonic spasm of the tensor tympani muscle), and I could distinctly see the increased tension of the membrana tympani, which was produced at each contraction of the muscle. It is well known that some persons can produce, at will, these contractions of the muscle with the attendant noises, and Schwartze, Lucae, and Politzer* have given a thorough explanation of several cases.

* See Archiv für Ohrenheilkunde, B. II. 1, page 4. ; B. III. 2, page 201, etc. ; B. IV. 1, page 191, etc.

SIXTEEN CASES OF AURAL DISEASE CAUSED BY THE USE OF THE NASAL DOUCHE.

By D. B. St. JOHN ROOSA, M.D.,

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In the first number of these Archives* I reported "a case of pyæmia from suppurative inflammation of the cavity of the tympanum, induced by the use of the nasal douche." My statements and conclusions in this case have been subjected to some criticism on the one hand, while on the other, my views as to the dangers from the employment of the appliance in question have been defended and reasserted. The latest criticism that I have seen is contained in the article, by my friend Professor *Elsberg*, which appeared in the last number of this periodical.† In summing up the cases of aural disease that have been caused by the use of Weber's mode of cleansing the nasal passages, Dr. Elsberg remarks that "if it be deemed necessary to analyze the cases of accident published, it may be seen that Roosa's case is uncertain." Unfortunately Dr. Elsberg has failed to give the analysis

* Vol. I. No. 1, p. 359. † Vol. II., p. 77.

which led him to this conclusion, and I therefore feel bound to give my own, which, it is believed, renders it anything but an uncertain case, whatever it may have seemed before. Before doing so I must confess my surprise at so vague a criticism upon the report of a case which has excited considerable attention, and which is deemed of sufficient importance to demand counter-evidence. It may be supposed, however, that the etiology has not been made sufficiently clear to my friend. I will therefore present some details in regard to this case, and at the same time take the opportunity afforded me of presenting some new cases, which have more fully grown on my belief that the nasal douche is an appliance which is quite often the cause of severe and dangerous aural disease, even when *properly employed.*

My answer to a criticism* of a similar nature to that made by Dr. Elsberg, that is, doubts as to whether the douche actually caused the aural inflammation, appeared in the Monatsschrift für Ohrenheilkunde,† and I will reproduce the essential parts of that answer here, inasmuch as it does not seem to have been generally read in this country. The patient in question, whose case is considered uncertain, was advised to use the douche by a physician (not by Dr. Jenkins, however, who sent him to me), for a nasal catarrh. It was used with all the precautions upon which Dr. Elsberg lays stress, except the one of holding the tongue out of the mouth with the hand.

* No. 12, 1869. † No. 4, 1870.

These precautions have been well regarded by the profession ever since Dr. Thudichum brought Weber's apparatus to our notice, and there is nothing new in dwelling on such points as those so ostentatiously made to physicians who have seen aural disease caused by the douche, to wit: that the water should be warm and salted, the power of the steam slight at first, and so on. I used the douche for some months on my patients, observing all these precautions, until I saw a perforation of the membrana tympani occur, when I desisted and advised others to do the same.*

But to return to our patient. In a note to me he states that he always had an unpleasant sensation in the ears when the douche was used, but he persisted in it until, each day finding his hearing, which had hitherto been good, more and more impaired, and at last having a decided ear-ache, he went to Dr. Jenkins, who advised him to abandon the use of the douche and to consult me about his ears. I found the gentleman suffering from acute aural catarrh, as I have before stated. He was promptly relieved by the use of leeches, and so on. I then undertook the care of his catarrh, and he was getting on slowly, when one day, on a visit to the medical friend who had prescribed the douche, he again tried a warm solution of carbolated water, with a moderate degree of pressure. He again had the unpleasant sensations in his ears; these increased, and when I was called to him, thirty-six hours after, he had acute inflammation of each middle ear: on one side

* Tröltsch on the Ear; English translation. 2d Edition, p. 369.

the mastoid cells were dangerously involved; on the other, suppuration of the drum-membrane occurred. I think the etiology is here sufficiently plain, inasmuch as the patient never had any aural symptoms until the douche was used. I do not go into the question as to whether this patient really had pyæmia or not, this doubt having been sufficiently met in my previous answer; and as it has no importance with reference to the subject now under discussion, I beg to refer any who may wish to learn more of that point to these ARCHIVES and to the Monatsschrift, *l. c.* The only point that can be at all "uncertain" is, as to whether the douche was properly employed. We shall find, however, I think, that authorities differ very much as to what is proper employment. The cases which are about to be added to this original one, can scarcely be subjected to that criticism even. Their etiology is as plain as cause and effect can be.

Before passing on to these cases, however, I beg to refer to an interesting article by Dr. Frank,* which he states he was induced to write by the report of my case—which, however, he did not attempt to discredit, although he gives some rules which he believes take away the dangers of the appliance. He first strengthens my view by relating a case of accident to his own ears while using the douche. A drop of water passed into the cavity of the tympanum at some chewing, swallowing, or sneezing movement during the use of the douche; perhaps in consequence, as he says, of the wide pharyngeal orifice

* Archiv für Ohrenheilkunde, Bd. 5, S. 202.

of his Eustachian tube. He had, as a consequence, acute aural catarrh. He then proceeds to lay down rules for the use of the douche, which I beg to contrast with those of *Thudichum* and Elsberg, as grounds for my assertion that authorities differed as to what are proper rules.

Thudichum :*

1. Use warm solutions—of the temperature of the blood—of salt, sugar, or milk.

2. The patient is told to breathe through his mouth exclusively, and to abstain from swallowing. He also states, " Persons who have control over themselves will always bear the experiment; but young persons, nervous females, and children become confused, begin to cry or to swallow, and breathe through the nose."

3. Pressure is to be slight at first.

4. The use of medicinal solutions to be begun with the greatest caution.

Now these are essentially the rules under which the profession in England and the United States began the use of the douche, and I submit that it is no answer to reports of cases of aural inflammation caused by the use of the douche, to italicize the words "*properly employed*" and point the reporter of the case to them.

Elsberg's rules are—

1. Solutions of salt are to be used.

2. The temperature should be nearly that of blood-heat.

3. Involuntary swallowing must be prevented, there-

* On Polypus in the Nose, etc. London, Churchill, 1869, *passim.*

fore the mouth should be always opened, and the tongue held out.

4. The pressure must be slight at first.

A comparison of these precautions will substantiate the statement that we, who used the douche, knew the importance of Dr. Elsberg's directions as to the management of the douche before his article was written—since Dr. Thudichum published his first paper in the *Lancet* of July 13, 1867, p. 40.

Dr. Frank, however, not satisfied with these precautions, and recognizing the fact which I hope to plainly show, that accidents do occur even when they are carried out, lays down a really new set of rules.

1. The douche is not to be used until the patient breathes quietly. If the respiration be at all accelerated the breath cannot be long held, and there is felt an urgent necessity of swallowing.

2. The stream should be a powerful one: "*Ich lege grosses Gewicht auf die Anwendung eines intensiven Strahls.*"

3. Pauses should be made during the douche, at first while ten is counted, later while twenty.

4. At the instant the douche is stopped, the water should be cleared from the nose and the patient should swallow with the nostrils and mouth closed.

These rules have at least the virtue of recognizing the great danger in the use of the douche,—that is, the one which I first pointed out,—the entrance of water into the middle ear; and they may be commended to those who

believe that any rules will prevent a patient from an involuntary swallowing motion. The first accident I ever saw, and which, as I have said, that which caused me to desist from the use of the douche, was a case where severe sneezing was produced while the apparatus was being used in the usual way, which ended in a perforation of each membrana tympani. The douche was used with warm salted water.

I beg now to present additional cases, where under ordinary precautions, such as were laid down by Thudichum, accidents occurred and serious consequences to the ear. Dr. Knapp's case* we shall be obliged to discard because cold water was used, although my readers will, I think, with me believe that the temperature of the water must have been changed after it entered the tube and before it reached the ear.

Dr. Pardee† reports several cases of acute aural inflammation from the douche, which Dr. Elsberg attempts to dismiss in a summary way. The first case which Dr. Pardee quotes is one in which the patient suffered from nasal catarrh, but had healthy ears,—and I here state a fact not before published,—a patient who was advised to use the douche, and instructed in its use by Dr. Elsberg himself, and who thought at least that he was carrying out the doctor's instructions. He is one of the "1,600 cases" that did not return to tell of his accident, and I can testify to the severity of the disease of

* These ARCHIVES, Vol. I. No. 2, and Transactions American Otological Society. Second year.

† Medical Record, Vol. 4, p. 530.

the ears which he suffered from, and to the fact that he is now, if living, permanently deaf from the loss of both membranæ tympani and necrosis of the middle ear. I consider that his chances of life are so few that no Insurance Company would take him as a risk. While I never saw the patient use the douche, I believe, from his statement, that he used it as advised by his competent physician; that he employed it properly. It is the case which is spoken of by Dr. Elsberg as resting only upon "the intelligent and straightforward statement of the patient."

The second case reported by Dr. Pardee I also saw, and although Dr. Elsberg considers it as quite well disposed of when he quotes the patient's statement to Dr. Pardee, that he neglected to open his mouth as widely as usual, when a drop trickled down the throat and involuntary swallowing took place, I beg to add that this patient was a very intelligent medical student, who was carefully advised as to how he should use the douche, and that by no less authority than a professor in one of the New York medical colleges. Now if such a patient, advised by such authority, is so stupid as to "neglect to open his mouth widely enough just at the proper time," and consequently has, as this patient had, an acute aural catarrh, lasting, to my knowledge, some weeks and requiring active treatment, what will be likely to happen to an ordinary person who takes up the use of the douche and learns it from a patient who has learned it from a physician?

I will now add a case from my note-book which has not before been published.

In March, 1870, I was consulted by Dr. ——, of Kansas, who informed me that he had always had sound ears until August of the preceding year, when, while using a nasal douche, one of his ears felt filled up, and in a few days the other. He then performed the Valsalvian experiment, when his membranæ tympani perforated. I found the membranes nearly destroyed by suppuration.]

I believe it would have been much better for the patient to have suffered for his whole life with nasal catarrh, for which he was using the douche, than to have thus injured his ears, and put his life in the danger that every patient with a suppurating drum-membrane is in. I do not think any amount of analysis can discard such cases as these, as being serious cases of aural disease caused by the use of the nasal douche. I cannot say positively that this patient did not use cold water, but I think we may take it for granted that he was well informed as to the proper way of using the douche, since it was widely taught when the appliance was brought to our notice in America by Dr. Thudichum.

A patient presented himself at the Manhattan Eye and Ear Hospital on August 30, 1871, when he was under the care of Dr. Pardee, with the usual symptoms of acute aural catarrh. He stated that he never had any ear disease until he used the douche. He soon recovered his hearing under the usual treatment.

Dr. Arthur Mathewson, Surgeon to the Brooklyn Eye and Ear Hospital, has given me the notes of the subjoined case:—

Mrs. C., æt. 30, had been using the douche for some time for relief of catarrh, by the advice of her physician, an eminent practitioner in Brooklyn. Suddenly one day, while using it in the ordinary manner, she experienced acute pain in the left ear, which was followed by a very severe attack of otitis media. Dr. Mathewson then states: "I was called to see the case after it had been going on for two or three days, and found that it was one of the most severe I have ever had to do with, the pain being excessive and continuous, and for a long time obstinately resisting all the usual remedies. There was a large perforation of the membrana tympani with profuse suppuration. The hearing power was for a time almost completely abolished."

Dr. Mathewson has seen three cases in which aural inflammation has occurred from the use of the douche, but of which he has no notes. Dr. C. E. Hackley, Aural Surgeon to the New York Eye and Ear Infirmary, has sent me the notes of the following case, which is unique in so far as the patient had a perforation of the membrana tympani before the douche was used, and yet otitis occurred, a fact which suggests the inference that the force of the current, or its mode of entrance, had something to do with the causation of the inflammation, since the middle ear is usually flooded with warm water from the *external meatus* with impunity.

Mr. C. L. C., æt. 23, applied to me, February 27, 1869. I found from his statement that when three years old he had purulent inflammation of the middle ear with perforation of the membrana tympani. The inflammation ceased, but the perforations continued. His hearing was fair, however, and he had had no trouble with his ears for years past, till three weeks previous to his visiting me. Then, after the use of the nasal douche with *warm salt water*, purulent discharge began

from his ears. This he attributed (and I think correctly) to the nasal douche.

Dr. Hackley continues: "I have seen one other case of purulent inflammation of one ear (the notes of which I cannot find) where trouble seemed distinctly traceable to the use of the nasal douche. While I believe these inflammations to have been caused by the warm salt water, I think it strange that it should have been so, never having seen a similar trouble arise from intentional injection of the same fluid through the Eustachian catheter, or the perforated membrana tympani into the middle ear."

I will now append two cases which Dr. Pardee* reported in a subsequent paper to that from which Dr. Elsberg quotes.

The first was in the practice of Dr. H. G. Piffard, of New York. A young gentleman had been suffering for some time with naso-pharyngeal catarrh, complicated with great enlargement of the tonsils. He began the use of the nasal douche with warm fluids. On one occasion, a few days after, he noticed that there was some nasal obstruction, followed by the entrance of fluid into the Eustachian tube. A few hours after he began to feel pain in the right ear, which by morning was excessive. On examination Dr. Piffard found that the patient had *otitis media acuta*. He recovered under the use of leeches, etc. The fluid used in the douche was a warm solution of common salt. The patient was an educated gentleman who, as Dr. Piffard stated, perfectly understood the management of the douche.

In the same paper an additional case of my own is reported, which reads as follows: "I was consulted by a prominent member of the legal profession in regard to

* New York Medical Gazette, Vol. VI., No. 23.

his eyes. He incidentally stated that he had naso-pharyngeal catarrh, for which he was treated by a well-known laryngologist for weeks by the nasal douche, *the doctor himself using the douche at every application*; that he at last got such an unpleasant feeling in his ears, and became so deaf, that he became alarmed and did not visit the physician again, when his deafness was gradually relieved."

I also saw last summer, in consultation with Dr. E. G. Loring, Jr., a case of severe suppurative inflammation of the middle ear, with periostitis of the mastoid, which was caused, as the patient believed, by the use of the nasal douche, under the advice and instructions of a competent physician. Dr. Mathewson, who has already furnished a case for this paper, informs me that he treated a homœopathic physician for severe otitis media, which came on while he was using the douche under the usual precautions and with warm water.

Dr. M. also furnishes me with the following account of a case which has just come under his observation:—

A physician consulted him in regard to an aural affection and gave the following history. Two years ago, after using the nasal douche, he had experienced a good deal of pain in the ears, which lasted for two days. He had used it since, however, having found that it gave relief to a nasal catarrh, and for two weeks past he has had a feeling of fulness in the ears after using it, with tinnitus and impairment of hearing. There was, however, very little pain, and that only occasionally. The patient states that he has several times felt the water pass into the Eustachian tubes of both sides, and that he has relieved the ears of the sense of fulness by the performance of the so-called Valsalvian experiment.

He also states positively that he *had driven the water out of the tympanic cavity into the external auditory canal*, and that he has felt the fluid with his fingers as he turned his head to one side. Dr. Mathewson then states that he examined the membranæ tympani, and that he found them nearly normal in appearance. There is no perforation in either of them, and he queries, did the fluid pass through the Rivinian foramen? The patient observed that the fluid was less apt to pass into the Eustachian tube with a high pressure than with a slight one. The hearing of one side is impaired.

I have just seen a well-known medical gentleman of this city who informed me that he was one evening using the nasal douche with a warm solution of salt in water, when he became suddenly faint and unconscious. When he recovered he found that he was suffering from pain in both ears. The douche was being used in the usual manner, and no accident of any kind had occurred until the fainting came on.

Dr. O. D. Pomeroy, of this city, was using the nasal douche in the case of a patient who had on one side catarrh of the Eustachian tube, on the other *otitis media suppurativa.* Warm salt water was the fluid used. Suddenly the patient felt water passing into the sound ear, and instantaneous pain occurred. A severe otitis, with subsequent perforation of the membrana tympani from suppuration, occurred. Dr. Pomeroy also states that all was going on regularly in the use of the douche, until water was felt to pass into the ear.

The number of cases thus reported could, without difficulty, be doubled, and I am confident that otologists will have occasion to see many more cases of aural disease whose proximate cause is to be found in the use of Weber's nasal douche, if it continues to be prescribed in the reckless manner that it has been. I have purposely omitted several cases, such as that reported by Dr. W. W. Seeley,* where cold water was used and where dangerous

* Transactions of the American Otological Society. Fourth Annual Meeting.

otitis occurred. If such cases were admitted, the damage done by the douche would be really considered frightful by those who rightly estimate the value of an intact membrana tympani and a healthy middle ear.

ANALYSIS OF CASES.

	Patient.	*Instructor in use of Douche.*	*Fluid used.*	*Ear Disease Produced.*
Case 1.	Rev. Dr. C.	A physician.	A warm solution of carbolic acid.	Acuta otitis media suppurativa. Pyæmia. Recovery.
" 2.	Dr. Frank.	Dr. Frank.	Cold water, which he advises in all cases.	Acute otitis media. Recovery.
" 3.	Mr. D.	Dr. Roosa.	Warm solution of salt and water.	Perforation of both membranæ tympani. Recovery.
" 4.	One of Pardee's cases.	Dr. Elsberg.	Warm solution of salt and water.	Otitis media suppurativa. Necrosis of middle ear. Permanent deafness.
" 5.	Second of Pardee's cases. Medical Student.	Prof. Thomson.	Salt and water.	Acute otitis media. Recovery.
" 6.	A Physician.	A physician.	Unstated.	Otitis media suppurativa chronica.
" 7.	Patient at Manhattan Eye and Ear Hospital.	Unknown.	Unknown.	Otitis media acuta. Recovered.
" 8.	Mrs. C. Dr. Mathewson's case.	Physician of Brooklyn.	Warm fluids.	Otitis media acuta. Recovered.
" 9.	Dr. Hackley's case.	Unknown.	Warm salt water.	Otitis media suppurativa chronica, supervening on old perforations.
" 10.	Dr. Piffard's case.	Unknown.	Warm fluids.	Media acuta. Recovery.
" 11.	Judge ——.	Dr. Ruppaner.	Unknown.	"Deafness." Recovery.
" 12.	Dr. Loring's case.	A physician.	Warm fluid.	Otitis media suppurativa chronica.

	Patient.	Instructor in use of Douche.	Fluid used.	Ear Disease Produced.
Case 13.	Physician. Dr. Mathewson's second case.	Physician.	Unstated.	Otitis media acuta. Recovery.
" 14.	Physician. Dr. Mathewson's third case.	Physician.	Unstated.	Otitis media subacuta.
" 15.	Physician.	Physician.	Warm salt water.	Fainting and otitis media catarrhalis.
" 16.	Dr. O. D. Pomeroy's case.	Dr. Pomeroy.	Warm salt water.	Otitis media suppurativa.

These cases seem to me to prove that even when the douche is used with care, by competent persons, it is a dangerous appliance. The bad effects are probably due to the entrance of fluid into the middle ear through the Eustachian tube. It is probable that this may occur many times, producing the sense of fulness in the ears, which many patients who use the appliance complain of, before any serious harm occurs, and I believe that this constant flooding of the tubes will, in many cases where no acute symptoms are produced, prepare the way for an insidious form of chronic aural catarrh.

If it be objected to this theory of the cause of acute otitis that aurists often inject fluids into the Eustachian tube, I would answer that this is done in cases where the mucous membrane is already diseased, and not in sound ears, and then in minute quantities, under the most careful supervision of the effect produced on the middle ear.

The argument against the efficacy of the douche, even as a means of treating naso-pharyngeal catarrh, which was first made by Dr. Pardee, I think is convincing; but for that I beg to refer my readers to Dr. Pardee's paper in the *Medical Gazette*.

CONTRIBUTIONS TO OPHTHALMOTONOMETRY.

By Dr. E. Pflueger,

Late Assistant to the Ophthalmic Clinic in Bern.

Translated by Dr. Emil Gruening, of New York.

During the last years, researches on intra-ocular pressure have, in a high degree, occupied the attention of ophthalmologists. From the earliest times the hardness of glaucomatous eyes had been mentioned in treatises of ophthalmology. Not until latterly, however, and chiefly through the investigations of A. v. Graefe, has this question risen to importance. Von Graefe considered all symptoms of glaucoma as secondary phenomena, consequent upon an increase of intra-ocular pressure, and maintained that iridectomy was the only remedy against this disastrous affection. Under discussion, this subject became very prolific in two directions. First, it gave the impulse to investigations as to the cause of the increase of intra-ocular pressure. The experimental investigations of Wegner, Hippel, Grünhagen, Adamük, Mimocky, and many contributions to the knowledge of glaucoma, are directly traceable to this source. Secondly, A. v. Graefe, Donders, Hamer, Dor, Weber, Monnik, con-

structed ophthalmotonometers, and thus endeavored to establish a standard measure of intra-ocular pressure. At present, ophthalmotonometry has not yet become a positive branch of science, but it assists the palpating finger, and affords a more accurate means of observation. This method does not enjoy the favor of all ophthalmologists—its opponents are still very numerous.

At the ophthalmic clinic in Bern, Prof. Dor taught me the use of his tonometer, and convinced me of its practical value. When I began to institute my tonometrical researches, Monnik had already described, in an inaugural thesis, his first and certainly less perfect instrument; this I failed to obtain, though I wrote to Utrecht repeatedly. My experiments were therefore limited to Prof. Dor's instrument, the only one at my disposal. I discarded the use of the other well-known tonometers. Last year I had the opportunity of communicating personally with Monnik on the subject of his tonometer, and to make some measurements jointly with him. But, as I had already gathered the material for this paper, and had no time for an extensive series of comparative researches, I must limit myself to the publication of the results obtained with Dor's instrument.

I endeavored to recognize the sources of error inherent to the tonometer, drew up a comparative table of tonometrical and manometrical degrees, and expressed the degree of tension of normal eyes in Hg. millimetres. I furthermore added tonometrical observations on the effect of atropine and iridectomy upon intra-ocular pres-

sure, and concluded with the tonometrical measurements of more than 100 pathological eyes.

I may remark here, that in analogy with general usage I employed the terms "intra-ocular pressure" and "tension of the globe" synonymously, though, as is well known, the pressure transmitted from the media to the walls of the globe does by no means constitute the sole factor which determines the value of tonometrical measurements.

Prof. Dor stated in his paper on ophthalmotonometry, that he had a little hole drilled through the upper end of his tonometrical dial. He then, by means of a silk thread, suspended the instrument and allowed it to act by its own weight. Thus, the weight of the instrument, *i. e.*, a constant, was substituted for the rather variable mode of manual application. Dor's improved method undoubtedly furnishes more accurate results; during the last several years it was exclusively practised at the Ophthalmic Clinic of Bern; I employed it, also, in all the measurements recorded in this paper.

Weber, of Darmstadt, was the first who held that valuable results could only be obtained by substituting a constant for the manual application of the instrument. In Dor's new method, the silk thread by which the tonometer is suspended is best held between the teeth of the experimenter, whose one hand is employed to keep the lids open, while the other simply serves in guiding the instrument. The introduction of this new method removes the most obvious source of error of Dor's tonometer.

Sources of error of Dor's tonometer.

Various objections have been raised against Dor's tonometer; its usefulness has been questioned on account of its defects. The frequent use of the instrument led us to the conviction, already expressed by Dor, that the instrument, though far from being perfect, suffices for practical purposes, since it indicates such differences of intra-ocular pressure as will escape the notice of the palpating finger. The objections raised induced us to examine more thoroughly the sources of error pertaining to the instrument.

First, we shall consider the views of those opponents who doubt the correctness of the principle of the instrument.

In the following quotation, Weber designates the results obtained as somewhat comparable:—"I may be allowed to say 'somewhat comparable,' since I do not conceive how we can determine the depth of the depression which the instrument does not record, and by which the intra-ocular pressure becomes increased." It is certainly true that the depth of the depression cannot be read off, but it is easily computable. For this purpose we subtract the tonometrical value from 50; we then obtain the measurement of the depth of the depression expressed by twentieths of a millimetre. If, for instance, in measuring the curvature of an eye the index points to 25, we know at once that the height of the measured chord amounts to $\frac{15}{20}$ mm., since the graduation begins with 10.

In measuring the tension of the eye, we take the obtained value—15, as a starting point, and screw the style forward 2 mm., *i. e.*, we either move the style $\frac{40}{20}-\frac{15}{20}=\frac{25}{20}$ mm. beyond the marginal plane of the sheath, or push the sheath back the same distance. If the eyeball were, strictly speaking, as hard as stone, and could not yield in the least, the style would be pushed back 2 mm., and the index remain stationary at 50; if, on the contrary, the eyeball were very soft and void of tension, the style would descend 2 mm. and the index remain motionless. Should the index stop at 25, the style would sink into the eyeball $50-25=40-15=25$ twentieths of a millimetre, causing a depression of $\frac{25}{20}$ mm. It is evident that by the increase of intra-ocular pressure, the force which lifts the spring is raised, and the depth of the depression lessened. This explains why, despite a comparatively considerable increase of tension, the index of the tonometer advances but slowly. If our instrument were constructed like Monnik's, to indicate the degree of power requisite to cause the same depth of depression, it would certainly point more rapidly to higher figures. This, however, is of little importance to us, since we obtain the best exposition of our measurements by the commutation of tonometrical degrees into Hg. mm.

Other opponents maintain that in applying the instrument it is impossible to introduce a constant for the purpose of measuring a force. But it is undoubtedly true that the known and unchangeable weight of the

instrument, used solely and exclusively as an agent of pressure, represents a constant. In the first measurements published by Prof. Dor, no constant had been employed.

The sources of error which render our measurements inaccurate are numerous in this instrument, but more so in theory than practice. We may group them together as follows: *a*) Sources of error inherent to the tonometer; *b*) Errors from a faulty or inaccurate application of the instrument; *c*) Errors resulting from the demeanor of the patient.

a). *Sources of Error pertaining to the Tonometer.*

1). *A priori* we are led to suppose that changes of temperature and long use may alter the tension of the spring. But the difference in temperature between the warm season of the year and the heated room in winter is so slight, and has so trifling an effect upon the tension of the spring, that, in order to detect it, the most accurate methods of measurement are required. In case the spring should really become altered by age and use, it could easily be regulated by the weight of 15 grm. annexed to every instrument.

2). Monnik stated that in consequence of the considerable friction of the central style, the instrument appeared to him inconvenient for the measurement of curvatures. In his first monograph he subjected Dor's tonometer, and especially the friction of the style, to an elaborate criticism, to which I must refer. He examined the positions

of the index on the graduated arc in the following manner. He fastened the instrument vertically in a vice over one scale of a delicate balance and cautiously placed weights into the other scale; with every addition of weights he struck the vice gently with his nail. His results were as follows: When he intercepted the action of the index and added gramme weights from 10 to 60 grammes, he obtained *negative* differences of 1 to 4 grammes; *i. e.*, the values to which the index pointed were always lower than the corresponding weight in the other scale. With a small weight the difference was greatest, with an increase of weight it diminished. A weight of 14—18 grm. yielded a difference of 4 grammes; a weight of 59 grammes of but 1 gramme. When, in order to obtain accurate results, the action of the index was not impeded, and from 15—67 grms. were placed, one by one, upon the scale, the negative difference varied between 5 and 9 grammes. Without the insertion of the index, and with the addition of 10 grammes at a time, Monnik obtained negative differences of 7 to 13.5 grammes. When the action of the index was introduced his results were as follows:

A weight of	10	grm.	corresponded to	10	tonometrical	degrees.
"	20	"	"	12	"	"
"	30	"	"	14	"	"
"	40	"	"	25	"	"
"	50	"	"	40	"	"
"	60	"	"	49.5	"	"
"	70	"	"	50.5	"	"

I was greatly surprised at these results, as I knew

that the graduation of the arc had been empirically determined with great accuracy by inverting the instrument, fastening it vertically, adding gramme weights one by one, and recording the different positions of the index. I then examined, after two different methods, the instrument used for several years at the clinic in Bern.

First. I followed the above-mentioned method by which the graduation had been determined. I inverted the tonometer, added weights of 10 grammes each successively, and allowed the index to act. I may furthermore remark, that with my nail I gently struck either the vice or the table. The results obtained were as follows:

A weight of	10	grm.	corresponded	to	15.5	tonometrical	degrees.
"	20	"	"		25.5	"	"
"	30	"	"		35.5	"	"
"	40	"	"		45.5	"	"
"	50	"	"		55.5	"	"

In these results we find a constant positive difference of 5.5 grm. These 5.5 grammes represent the weight of the rod minus its friction.

Secondly. I employed Monnik's method, examined the instrument by means of scales, introduced the action of the index, and gently rapped the table with my nail.

A weight of	20	grm.	corresponded	to	13	tonometrical	degrees.
"	30	"	"		23	"	"
"	40	"	"		33	"	"
"	50	"	"		43	"	"
"	60	"	"		53	"	"

13, 23, etc., represent the average results of three different examinations. In my experiments the deviations from these average results never amounted to 1°; they were always < 1°, mostly < 0.5°. Thus there exists a vast difference between my results and Monnik's variations of 16 and 19°. When the spring was removed and we attempted to introduce the central style in a vertical direction, we were obliged to place upon the other scale a weight of seven grammes; in our last experimental series these seven grammes constituted the negative difference; they represent the weight of the rod plus its friction (a + b). From a + b and a − b we obtain a = the weight of the rod 6.25 grm. and b = the friction 0.75 grm.; in Monnik's experiments the latter is 1.6 grm. I can only explain the great difference between Monnik's results and my own by assuming that Monnik made use of a very defective instrument. Last winter I had an opportunity of examining this very instrument at the clinic of Utrecht, and became convinced that it offered a greater resistance than the tonometer which we had employed. However correct Monnik's statements may be with reference to his own instrument, they are not applicable to other tonometers. We must, however, concede that in the horizontal application of the instrument, *e. g.*, in determining curvatures, the resistance of friction is greater than in vertical positions. In very soft eyes this increase of friction may become a source of errors and inaccuracies, but it will exert no influence upon eyes the tension of which is either slightly

diminished or increased, and in which tonometrical measurements have in reality a practical significance. The resistance of the style does not materially alter the shape of the surface to which it is applied.

Thirdly. Monnik objects to the great thickness of the ivory style, and apprehends an alteration in shape of that portion of the sclera which comes in contact with the tube. But here again we find conditions similar to those mentioned in the question of friction. In very soft eyes, in which the depression caused by the style amounts to $\frac{30}{20}$ mm. or more, the alteration of the surface may extend to the tubal zone. In cases of slight diminution or increase of tension the depth of the depression amounts to $\frac{25}{20}$ mm. or less, and the alteration of the scleral surface within the tubal zone is very insignificant. In order to determine the extent and constancy of the influence exerted by the thickness of the style I had another style made of half the thickness of the first, and with these two styles instituted comparative measurements of 45 eyes. In all the cases, excepting five, I obtained equal degrees of curvature; in none of the five did the difference amount to more than 0.5 twentieths of a millimetre. On an average, the values of tension obtained with the thicker style exceeded those found with the thinner style by 5 tonometrical degrees; there were extreme differences of 3, 5, and 6 degrees. I think that by reducing the style in the transverse diameter to one-half or one-third of its ordinary size, and by narrowing the calibre of the tube, we would obtain an instru-

ment of greater accuracy and lighter construction. This modification also offers the advantage of rendering the application of the instrument easier and more exact in cases of narrow palpebral fissure. If we alter the size of the style, we shall require a new tabular record for manometrical comparison.

Fourthly. The new tube devised by Dor for the mea surement of curvatures in different meridians touches the sclera only in two points, and may, by a somewhat oblique position, easily lead to inaccurate measurements. The old tube is placed with its whole periphery upon the sclera, and facilitates the correct application of the tonometer to the eye under examination. From an oblique position of the tonometer, inaccurate measurements must necessarily result; first, by the increase of friction, and secondly, by the irregular distribution of the constant over the different parts of the tubal periphery and the style. For this reason I discarded the modified tube and employed the old form.

I shall here mention one circumstance which, though of practical interest, does not strictly relate to our subject. The instrument which, through the kindness of Prof. Bowman, I was allowed to use at Moorfields Hospital, in London, had a defect that had escaped notice. Its fixed zero mark did not correspond to the zero of the revolving disc, but to the second subdivisional line; *i. e.*, the terminal plane of the central style coincided with the plane of the lower limiting surface of the tube, whenever the disc was rotated to the right, one and one-half

subdivisional lines beyond zero. The central style had been set $\frac{3}{20}$ mm. too high. From this resulted a constant error in the measurement of curvature, which naturally reacted upon the measurement of tension. An experimenter, skilled in the use of the instrument, could nevertheless have obtained correct measurements by starting from the third subdivisional line instead of zero. The defect of the instrument could have been remedied by lowering the bar and hooking it into the first or second lower tooth of the ratchet-wheel.

A priori, the points hitherto mentioned appear to constitute sources of error; these, however, dwindle into insignificance upon more thorough examination. The objections raised in 1, 4, and 5 are of little or no import; those contained in 2 and 3 are theoretically well founded, but practically irrelevant; their value may amount to 0.5 degrees at the utmost.

b. Errors due to a faulty or inaccurate application of the instrument.

The experimenter who is not fully familiar with the use of Dor's tonometer will, in the beginning, commit a series of mistakes; these, however, are not attributable to the instrument as such, but to the observer, who by some practice will easily learn to avoid them.

1. The principal mistake hitherto committed in the application of the instrument was that, in pushing the style 2 mm. forward, the curvature was disregarded. I am convinced that, despite Dor's urgent directions, the

primary position of the style was mostly accepted as a starting-point for these 2 mm. instead of the secondary position resulting from the measurement of the curvature. In illustrating above the method of measuring the depth of the depression I, at the same time, explained how we may determine the curvature in measuring the tension.

2. The eyes under examination should be measured in identical positions. The non-observance of this rule will likewise engender errors. I commonly instruct the patient to turn his head not quite half a right angle in the opposite direction, and to look intently at an object placed in close proximity on the same side and almost on a level with his head. The eyeball is thus moderately rotated inwards, and presents, in the majority of cases, a sufficiently extensive scleral surface for the application of the instrument. Excessive lateral movements of the eyes without rotation of the head, as well as rotation of the head without corresponding movements of the eyes, may give rise to slight alterations of intra-ocular pressure. I have not yet been able to reach definite conclusions as to the degree of alteration which convergence produces in the eyes of living persons, but I observed repeatedly that in the extremes of slight and forced abduction the eyes of dead persons showed tonometrical differences of three to four degrees.

It is important to apply the tonometer carefully and gently; for if this step be executed rapidly and impetuously the elasticity of the sclera would act upon the

spring, and displace the index. Similar precautions are required in removing the instrument.

4. Every oblique position of the instrument furnishes erroneous results.

The first of these four points cannot properly be styled a source of error; we should rather designate it as an avoidable blunder. The other three points contain sources of error which are almost inevitable in the first measurements of an inexperienced observer. Of the extent of these inaccuracies we can best judge by comparing the measurements made by different experimenters on the same eyes. For this reason my friend Dr. Diem and myself measured, independently of each other, the tension of twelve eyes. In five cases our results showed a difference of 1°, in other five cases of 0.5°, and in the remaining two of 0°.

As we did not consider ourselves entitled to draw conclusions from so small a number of measurements, we proceeded to examine ten additional eyes, jointly with our colleague Dr. Burkhalter. In six of these ten cases Diem's results were perfectly identical with mine, while Burkhalter's showed in four cases a difference of 1°, and in two cases of 0.5°. In the remaining four cases, however, our results were fully identical. In our first comparative measurements we obtained the greatest differential results; these gradually grew less, and were finally *reduced to zero.* This proves the correctness of our assertion, that the sources of error mentioned in 2, 3, and 4 exist principally for unskilled experimenters, and that

with the acquisition of practice in the use of the instrument these inaccuracies diminish, and finally dwindle into nothing. If we, therefore, note 0.5° as the average value of these three sources of error, our estimate may be rather too high than too low.

c. Sources of error dependent upon the demeanor of the patient.

The patient may render an accurate measurement impossible:

1. By closing his lids. The closure of the lids augments the intraocular pressure and prevents the free application of the instrument. If the lids come in contact with, or press against the tube, the whole weight of the tonometer cannot act, and the constant is partly annulled. In many cases a lid-holder proves very serviceable; it prevents the transmission of palpebral pressure to the eyeball, and gives ample space.

2. By moving the eye during the measurement. Many patients keep their eyes steady; others cannot suppress a slight twitching. With regard to this point Dor's tonometer possesses the practical advantage over Monnik's, of not being more perceptibly influenced by very slight twitchings than by the gentle rapping of the nail against the table or the vice. In Monnik's very sensitive instrument the slightest twitching pushes the index several subdivisional lines forward, and renders the measurements inaccurate. As the terms "slight," "very slight," cannot be defined precisely, we are inclined to consider this factor as a source of error averaging 0.5°.

There are, however, a certain number of patients in whom it is impossible to obtain exact results. They are either nervous, hysterical women, without a will, or unruly men who close and press their lids, and move their eyes restlessly. We may here also group those cases in which the twitching is entirely beyond the control of the will, as in nystagmus. Here no instrument will be found available, and least could be accomplished with a tonometer of greater precision and sensitiveness than Dor's; we therefore resort to palpation.

Summing up the results of our examination of these three different series of errors, we find that each series affords an average range of possible errors of 0.5° To., yielding a total of 1.5°. This supposes the correct construction and faultless adjustment of the instrument. We are fully convinced that in judicious patients the errors of the last series may be avoided wholly, and that, furthermore, the acquisition of skill in the management of the instrument may render those of the second series insignificantly trifling. A concurrence of such favorable circumstances may reduce the range of possible errors to 0.5° = about six mm. Hg. This result proves clearly the correctness of the assertion that the instrument suffices for practical purposes. By the method of palpation it is impossible to appreciate a difference of intraocular pressure of 6 mm. Hg. If I remember rightly, A. v. Graefe was of opinion that a difference of less than 10 mm. Hg. cannot be elicited by palpation. But in order to estimate correctly a difference of 10 mm.

it is essential to possess the practical skill of A. v. Graefe.

The encouraging result of my investigations of the sources of error of the tonometer led me to a repetition of Dor's attempt of commuting tonometrical degrees into Hg. mm. I proceeded to examine twenty human eyes shortly after death, and followed precisely Dor's method of measuring human eyes.* The eyes were examined in situ, by means of an air-pump;—only water and no air was injected into the vitreous chamber. In selecting the eyes for my experimental purposes I was careful to obtain them fresh, and shortly after death.

On Table I. are recorded in tonometrical degrees the values of tension of twenty human eyes, with a gradual increase of their intra-ocular pressure from 0—300 mm. Hg. At first the mercury rises but slowly in the manometer:

From 20–90 mm. it rises 4 or 6 mm.

From 90–200 mm. it rises 10 mm.

From 200–300 mm. it rises 20 mm.

The average values are computed from 20 different series of measurements. For the sake of completeness I noted on Table I. the diseases of which the patients died —in the first horizontal row their ages, and in the last horizontal row the number of hours intervening between death and the experiment:—

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* Arch. f. Ophth. XIV. 1, 24.

TABLE I.

Manometrical pressure in millimetres.	I. Ramscier, S.; Complicated fracture.	II. Nägeli, C.; Necrosis oss. metatars. Ablatio pedis.	III. Eichenberger, S.; Typhoid fever.	IV. Staheli, Jac.; Hernia incarcerata.	V. Schmied, Joh.; Fractura cranii.	VI. Niederhäuser M.; Tuberculosis.	VII. Keller, E.; Typhoid fever.	VIII. Miescher, M. (O. d.); Typhoid fever.	IX. Ead. (O. 5).	X. Huber, Ros.; Tuberculosis.	XI.	XII. Hofer, Joh.; Peritonitis traum.	XIII. Schmied, Joe: Pyæmia.	XIV. Brönnimann, Joh.	XV. Weber, Jac. (O. 5); Tuberculosis.	XVI. Idem (O. d.)	XVII. Sträheli, Jac.; Meningitis chron.	XVIII. Wyss, Joh.; Hernia incarcerata.	XIX.	XX.	Average.
Age.	14	16	19	29	38	39	42	44	44	44	46	48	50	62	63	63	64	68	..	..	
0	17	15	16	23	17	16	20	18	17	15	20	17	17	21	21	19	22	20	17	16	18.2
10	20	15	17	25	20	..	17	..	..	..	20.5	21	20	16	18	17	22	18	20	15	18.8
20	19	17	21	26	21	20	18	21.5	21.5	17	21	21	20.5	19	22	18	..	23	19	15	20
		(14)													(20)						
26	19	15	..	26	..	..	..	..	23.5	..	..	23	20.5	..	..	..	22	25	19	17	21
30	19	..	23	26	23	21	20	22.5	24.5	18.5	22	23.5	21.5	..	23	22	24	26	19	18	22
36	20.5	18	23	..	..	..	22	23	..	24	23	22.5	22.5	..	22.5	22.5	..	27	20.5	18.5	22.1
40	23	19	24	25	25	22	23	24.5	25	25	..	24	23	22	23	23	..	28	23	20	23.4
46	24	19	25	..	26	..	24	22.5	..	26	23.5	24	22	..	..	24	28	..	24	24	24
50	24	20	24	26	26	23	24	24	..	26	24	24.5	25	24	26	25.5	..	30	24	25	24.7
56	25	22	..	26.5	27	23.5	24.5	26	..	..	..	26	26	..	..	..	28.5	29.5	25	..	25.8

60	26	21	27	..	27	24	25.5	..	26	26.5	25.5	27	27	25.5	27	26	28.5	..	26	27.5	26
64	27	22	..	..	..	..	..	24	..	27	26.5	..	27	..	..	26.5	..	..	27	28	26
70	28	24	29	28.5	28	27	27	24.5	26	28	28	28	29	26	27.5	26	29.5	30	28	27	27
74	28	24	..	..	..	..	..	..	26	28.5	28.5	..	28	..	..	..	31	30	27	29	28
80	..	25	30	30	29	27.5	28	25	27	29.5	29	28.5	30	29	28	26	..	31	..	28	28.2
84	29	26	..	..	..	..	..	25	..	30	30	..	..	..	..	..	31.5	31.5	29	..	29
90	29	26	30.5	31.5	30.5	28	29	25	29	31	30	29.5	32	30	30	29	32.5	33	29	30	29.8
100	30	26	30.5	32.5	31	29	31	..	30	31.5	30.5	30	32.5	31	30	30	34	34	30	31	30.8
110	30.5	26	31	33.5	32	29.5	32	..	31.5	..	31.5	31	34.5	33.5	30.5	31.5	36	35	30.5	32	31.8
120	31	27	31.5	34	33	30	33	..	32.5	32.5	33	32	35	35	32	32	37.5	36	31	33	32.7
130	31	27	..	34.5	34	30.5	34	31	33	34	35	33	36	35.5	..	33	37.5	..	31	34	33.2
140	32	28	33	35	34.5	32	34.5	..	34	35	37	33	37	36	33	33.5	..	..	32	34.5	33.8
150	..	29	34	37	35	33	35.5	..	..	35.5	38.5	33.5	38	36.5	34	34	..	..	32	..	34.7
160	33	30	35	..	..	..	35	34	35	36	39	33.5	39	38	35	..	..	..	..	..	35.2
170	32	..	..	37.5	36	34	..	34	..	37	40	34	39	38.5	36	35.5	..	..	33	..	35.9
180	..	31	..	37.5	36	..	36.5	35	35.5	..	39.5	34.5	39.5	39.5	37	..	..	..	34	..	36.2
190	34	..	..	37.5	37	..	..	..	..	..	..	35	..	39.5	36.5	36	..	..	..	..	36.5
200	34.5	..	36	38	37	35	38	37.5	37	38	..	35	..	..	36.5	..	..	..	34.5	..	36.6
220	..	..	..	38.5	38	..	..	..	..	..	..	..	..	..	..	36.5	..	..	34.5	..	36.9
240	34.5	..	..	39	38	..	..	..	..	..	..	..	..	..	..	37	..	..	..	..	37.1
260	35.5	..	..	39.5	38.5	..	..	..	..	..	..	..	..	..	38.5	38	..	..	35	..	37.5
280	36.5	..	..	39.5	..	..	..	..	..	..	..	..	..	..	39	38.5	..	..	36	..	37.9
300	37	..	..	40	39	..	..	..	..	..	..	..	..	..	39	39	..	..	37	..	38.5
Hours post mortem.	20	..	26	7	16	22	12	14	19	12	..	24	17	5	5	4	11	12	..	..	

In reviewing the series of average values, and comparing them with those previously recorded by Dor, we find that the figures of our scale are throughout higher than Dor's. The tension of the normal dead eye is the same in both series, viz., 18.2° To. With a pressure of 10 mm. Hg. Dor observed a decrease of the tonometrical value of $\frac{1}{4}$°. This was due to the escape of a trifling quantity of aqueous humor. Owing to the great number of our observations we obtained the higher mean of 18.8° To. In five cases we also noted a decrease. This amounted to 3° in case XV., to 5° in case XIV., and was caused by the loss of an inconsiderable quantity of vitreous humor. In cases XVI., XVIII., and XX. no such loss occurred, and we explain the tonometrical diminution by assuming that in the introduction of the thin troicart the pressure exerted upon the globe was sufficiently intense to expel all the blood from the inner veins. In both series 20 mm. Hg. correspond exactly to 20° To. With 30 mm. Hg. we obtained a difference of $2\frac{3}{4}$° To., with 50 mm. Hg. of 4.3° To., and, as we ascend, of about 4° To. This proves that even in the manual application of the instrument, Dor employed a tolerably constant pressure. In measuring the eyes of living persons we shall, no doubt, obtain, at least approximatively, the same differences.

Dor has already pointed out the peculiar relation between the increase of manometrical pressure and the rise of tonometrical values. His statements are corroborated in the main in our own table. For the sake of clearness

we here group together the tonometrical differences of every 10 mm. Hg., and from 200 mm. of every 20 mm. Hg.

The rise of Hg.

From 0	to	10	mm.	causes	the Ton. to rise	0.6°
10	"	20	"	"	"	1.2
20	"	30	"	"	"	2.°
30	"	40	"	"	"	1.4°
40	"	50	"	"	"	1.3°
50	"	60	"	"	"	1.3°
60	"	70	"	"	"	1.°
70	"	80	"	"	"	1.2°
80	"	90	"	"	"	1.6°
90	"	100	"	"	"	1.°
100	"	110	"	"	"	1.°
110	"	120	"	"	"	0.9°
120	"	130	"	"	"	0.5°
130	"	140	"	"	"	0.6°
140	"	150	"	"	"	0.9°
150	"	160	"	"	"	0.5°
160	"	170	"	"	"	0.7°
170	"	180	"	"	"	0.3°
180	"	190	"	"	"	0.3°
190	"	200	"	"	"	0.1°
200	"	220	"	"	"	0.3°
220	"	240	"	"	"	0.2°
240	"	260	"	"	"	0.4°
260	"	280	"	"	"	0.4°
280	"	300	"	"	"	0.6°

This table shows the constancy of the increase of the tonometrical values, the absence of a negative variation, and the reduction of the increase with a higher manometrical pressure. This irregular but continual reduction becomes more obvious with differences of Hg. pressure greater than 10 mm. Hg.

The rise of Hg.

From	0	to	50	mm.	causes the	Ton.	to rise	6.5°
	50	"	100	"	"	"		5.1°
	100	"	150	"	"	"		4.9°
	150	"	200	"	"	"		1.9°
	200	"	300	"	"	"		1.9°

The reason why the tonometrical differences are so slight during the rise of the Hg. from 0–20 mm. has already been explained. In those cases in which the untoward accidents of loss of vitreous humor or sudden escape of venous blood are either very trifling or do not occur at all, we observe a rapid rise of the tonometer in the very beginning. In cases IV. and XVIII. we find a rise of 3°, in V., VI., and XII. of 4°, in III. of 5°.

It is surprising that with the rise of the Hg. from 60–70 mm. the index of the tonometer advances but 1°, and more than 1° with the rise of the Hg. from 80 to 90 mm. In attempting to discover the cause of this irregularity in the series of tonometrical differences, we ascertain that with the rise from 60–70 mm. Hg. the tonometrical values were reduced in two cases, remained stationary in other two cases, and increased only 0.5° in three cases. We therefore observe a negative variation in the

tension of the sclera in two cases. The following questions necessarily present themselves:—What conclusions as regards negative variations are we entitled to draw from the examination of our special cases if in the series of average values we find no negative variations? What is the relation of our average values to those published by A. Weber? Weber found that the tension of the ocular walls constantly showed a negative variation amounting, in the case of the sclera and with a pressure of 60–90 mm. Hg., to 1–2° To. From our table we learn that this phenomenon occurred in twelve eyes, and in several of these repeatedly (I., II., VIII., XIII., and XV.). The observed eighteen negative variations may be classed according to the degress of pressure as follows:—

With a	pressure of	20	to	50	mm. Hg.	9	neg.	variat.
"	"	60	"	90	"	6	"	"
"	"	160	"	180	"	3	"	"

Consequently we obtained in more than one-half of the eyes measured, negative variations. One-half of these were observed with a pressure of less than 60 mm. Hg., one-third with a pressure between 60 and 90 mm. Hg. I wish to call special attention to the variations observed in the cases II. and XV., in which, with the same pressure of 20 mm. Hg., I first obtained 17 and 22 respectively, and a very short time subsequently 14 and 20° To. I have sufficient reason to consider these figures as completely reliable, since each of them represents the average of at least three observations, in which the position of the eyes remained unaltered. I cannot determine the

cause of discrepancy between the observations of Weber and our own. It seems, however, highly probable that the slow rise of the Hg. allowed a gradual dilatation of the ocular membranes, the structural changes of which did not always occur so suddenly. (We assume the existence of structural changes in all cases of negative variations under a high pressure.) This view also explains satisfactorily the frequent immobility of the tonometer despite the rise of Hg.

It is, however, essential to refer again to Tab. I. for the sake of determining whether any conclusions may be reached as to the various influences of age, of the diseases that terminated life, and of the period of time intervening between death and the experiment. The ages were recorded in eighteen cases, and these may be grouped into cases under and over 45 years of age.

In the first group, containing cases under 45 years of age, we obtain, with 0 mm. Hg., an average tonometrical value of 17.4°; in the second group, of 19.6°. There is, consequently, in the latter group an excess of 2.2°. This agrees exactly with our results in the tonometrical measurements of normal living eyes at different ages. In the first group we find the lowest tension, *i. e.*, 15° To. in a case of tuberculosis, and in a case of caries of long standing, which finally rendered the amputation of the foot imperative. A tension of 16° To. was observed in a case of tuberculosis and in a case of typhoid fever. Unlike these exhausting diseases, strangulated hernia runs its course rapidly and shows the highest tension, *i. e.*, 23° To.

This case was examined seven hours after death. From the second group we cannot deduce such striking influences of the disease upon the tension of the dead eye-ball. As to the influence of the time of the post-mortem examination we can reach no definite conclusions. Upon the whole we may say that the later the examination is made the lower will be the degree of tension, and vice versa. It is remarkable that the tension of the three eyes of the patients who died of typhoid fever bears an inverse ratio to the time of the post-mortem examination.

It is, furthermore, of interest to note the shape of these twenty eye-balls, and their alterations with the rise of the manometrical column. In order to obtain the values of tension of Tab. I. we were obliged to measure the curvatures. The results of these measurements are grouped together in Tab. II. In the last row we placed the average values.

In Table II. we express in twentieths of a millimetre the height of a segment, which is determined by the diameter of the tube and the recession of the central style. With these data it is easy to construct the whole circle. The numbers indicate in twentieths of a millimetre the degree of recession of the central style during measurement.

TABLE II.

Pressure. Hg. mm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	Average.
0	6	5	4	13.5	12	11	12	5	7	15	6	6	5	10	14	15	9	12	7	11	9.3
10	9	7	..	13.5	15	17	13	..	..	..	8	12	5	7	14	15	9	..	..	..	11
20	11	14	13	13.5	15	17	13	14	12	..	..	..	6	..	14	16	..	..	14	13	13.3
30	11	15	..	13.5	..	..	..	15	12	14	..	14	..	..	14	16	14	12	14	14	13.7
40	14	15	13	14	..	17.5	13	15	13.5	15	11	14	8	13	14	16	14	12	15	14	13.7
50	15	15	13	14	15	..	13.5	15	13.5	15	11	14	..	13.5	15	16	14	12	15	14	14.4
60	15	15	14	14	15	17.5	13.5	15	14	15	12	14	..	14	15	16	14	..	15	..	14.6
70	16	15	14	14	..	..	13.5	15	15	15	12	..	..	14	15	16	14	..	15	14.5	14.5
80	16	15	..	14	..	17	..	15	15	15	..	15	11	14	..	16	..	12.5	..	14.5	14.6
90	16	15	14	14	..	17	13.5	15	15	15	12	15	11	14	15	16	14	13	15	14	14.4
100	16	16	14	14	14	17	13.5	15	15	14	12	15	11	14	14.5	16	14	13	..	14	14.4
120	15.5	16	14	..	14	16.5	13.5	..	15	14	12	15	11.5	14.5	..	15	14	13	16	14	14.2
140	15.5	16	..	..	..	16	14	..	..	13.5	12	..	11.5	15	..	15	..	..	..	13.5	14.1
160	15.5	15	14	13	..	..	14	..	15	..	12	14	..	..	14	..	..	..	..	..	14.1
180	15.5	15	..	13	14	..	14	17	..	..	12	14	12	14.5	14	14	..	..	15	..	14.1
200	15	..	14	13	13	..	13	15	15	..	..	..	..	14.5	13.5	14	..	..	..	..	13.9
220	15	..	..	13	13	..	..	..	..	..	..	..	..	..	..	14	..	..	..	..	13.8
240	15	..	..	13	13	..	..	..	..	..	..	..	..	..	..	14	..	..	..	..	13.8
260	14	..	..	13	13	..	..	..	..	..	..	..	..	..	..	14	..	..	..	..	13.6
280	13.5	..	..	13	13	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	13.5
300	13.5	..	..	13	13	..	..	..	..	..	..	..	..	..	13	14	..	..	..	..	13.4

The average numbers show that the sclera which after death is always found in a relaxed state, becomes gradually distended and assumes an approximatively globular shape, as the intraocular pressure is artificially raised to 60 mm. Hg. The greatest effect is produced by the first 20 mm. Hg., by which the height of the segment of the circle increases 4 twentieths of a millimetre; with the following 50 mm. Hg. the increase amounts only to 1.3 twentieths. To these $\frac{4}{20}$ mm. but little value can be attached, since the first two horizontal rows, representing the values of curvature for 0 and 10 mm. Hg., have no claim to accuracy. In more than one half of the cases (I. II. III. VI. VIII., etc.), the sclerotic was very much relaxed, it offered no resistance, but yielded to and became flattened by slight pressure of the style. This constitutes the source of error, mentioned in *a* 2, occurring in cases of very low tension. With a pressure of 20 mm. Hg. this source of error is trifling and practically insignificant.

A pressure of 60–80 mm. Hg. produces no alteration in the convexity of the sclera. With 70 mm. Hg. we find a very slight variation in the series of average values, but no analogy among our special cases. This is very natural, as the tonometer is inadequate to measure such slight degrees of difference. With the increase of pressure from 80 to 90 mm. Hg. the convexity diminishes somewhat; it then remains stationary up to 100 mm. Hg.; from 100 to 300 mm. Hg. it decreases very slowly, but continuously. The eyeball increases in size.

The latter 200 mm. Hg. diminish the height of the segment of the circle by $\frac{1}{20}$ mm.

From our special cases we draw the following conclusions:—

1. There are very considerable variations in the absolute size of the eyeballs. The extreme cases are VI. and XIII. in which, with a pressure of 80 mm. Hg., the difference in the height of the segments amounts to $\frac{6}{20}$ mm.

2. The elasticity or rigidity of the sclera varies greatly. The eye XVI. attains the greatest scleral convexity with a pressure of 20 mm. Hg.; but 180 mm. Hg. are required to produce the same effect in eye VIII., while the eyes X. and XV. begin to diminish in convexity, *i. e.*, become distended with a pressure of 100 mm. Hg. Other eyes retain their greatest convexity up to 200 mm. Hg. There are even cases, *e. g.* case III., in which we could observe no diminution of convexity. In no case was the pressure raised beyond 200 mm. Hg.

In order to determine the conditions of elasticity of the capsule of the globe, and its reaction upon the intraocular pressure, I instituted tonometrical measurements, with a gradual diminution of the artificially increased pressure, on nine of the eyes mentioned in our first two tables. In selecting these nine eyes, I was led only by my own convenience with regard to time. The rows *a* and *b*, in Table III., denote the tonometrical values with the same Hg. pressure; *a* with the rising manometrical column, *b* with the sinking manometrical column. The numbers of Table III. have the same significance as those

of Table I.; they express the intraocular pressure in tonometrical degrees.

TABLE III.

Pressure Hg. mm.	IV.		V.		VI.		X.		XII.		XIII.		XIV.		XV.		XVI.		Average Difference.
	a	b	a	b	a	b	a	b	a	b	a'	b	a	b	a	b	a	b	
0	23	25	17	11	16	14	15	14	17	—	17	22	21	10	21	20	19	—	2.6
10	25	26.5	20	12	—	—	—	—	21	21	20	23	16	12	18	21.5	17	10	1.8
20	26	—	21	12	20	17	17	21	21	21	20.5	26	19	15	22	23	18	15	1.1
30	26	27	23	16	21	17	18.5	23	23.5	23	21.5	27	—	18	23	—	22	16	0.9
40	25	—	25	19	22	18	25	24	24	24	23	28	22	20	23	23	23	21	1.3
50	26	29	26	24.5	23	19	26	25	24.5	26.5	25	—	24	—	26	—	25.5	23	0.7
60	—	—	27	—	24	22	26.5	26	27	27	27	31	25.5	23.5	27	26	26	—	0.3
70	28.5	29	28	26	27	24	28	—	28	—	29	32	26	25	27.5	27.5	26	—	0.4
80	30	—	29	27	27.5	25	29.5	28	28.5	30	30	—	29	27.5	28	—	26	—	1.2
90	31.5	—	30.5	—	28	—	31	—	29.5	—	32	34	30	—	30	28	29	—	0
100	32.5	—	31	31	29	28	31.5	31	30	30	32.5	36	31	30	30	—	30	29	0
110	33.5	34	32	—	29.5	—	—	—	31	—	34.5	36	33.5	31.5	30.5	—	31.5	—	0
120	34	—	33	—	30	30	32.5	32	32	31	35	37	35	34	32	31	32	31.5	0.3
130	34.5	34	34	32.5	30.5	—	34	—	33	—	36	37	35.5	—	—	—	33	—	0.3
140	35	—	34.5	—	32	—	35	33	33	—	37	—	36	—	33	34	33.5	—	0.5
150	37	35	35	—	33	31	35.5	—	33.5	34	38	38	36.5	36	34	—	34	33.5	0.8
160	—	35	—	—	—	—	36	36.5	33.5	—	39	38	38	37.5	35	34	—	—	0.5
170	37.5	—	36	—	34	—	37	—	34	—	39	39	38	—	36	—	35.5	34	0.8
180	37.5	35.5	36	—	—	—	—	—	34.5	35	39.5	—	38.5	—	37	35.5	—	—	1
190	37.5	36	37	—	—	—	—	—	35	—	—	—	39.5	39	36.5	—	36	—	1
200	38	36	37	—	35	—	38	—	35	—	—	—	39.5	—	36.5	36	—	—	1.3

The average difference is positive throughout; *i. e.* the average of *a* exceeds that of *b* by the noted values. The difference is greatest at the beginning and the end of the row, with either slight or very considerable augmentation of the intraocular pressure. Between 80 and 140 mm. Hg. the difference amounts to either 0 or only 0.3° To. I am, however, of opinion that these average differences are in reality too small, and that, by adding 1 on an average, we obtain a more correct result. This view is based on the fact that the eyes IV., XII., and XIII. show a negative difference throughout, *b* exceeding *a*, while in the other six eyes the difference is posi-

tive. I am inclined to think that the negative difference is due to an accidental obstruction in the caliber of the thin canula, perhaps to the entrance of vitreous substance, etc. Our results are therefore as follows:—

If in the dead eye the intraocular pressure is raised to 200–300 mm. Hg.; we obtain with the sinking column on an average 0.5–1° and 1.5–2° To. less than with the same height of the rising column. With very high and very low degrees of pressure these differences are considerably greater than with moderate degrees. A pressure of 200 mm. Hg. dilates the capsule of the eyeball beyond the coefficient of its total elasticity.

TABLE IV.

Pressure Hg. mm.	IV.		XIV.		XV.	
	a	b	a	b	a	b
0	13.5	13	10	5	14	12
10	13.5	13	7	9	14	14
20	13.5	13	—	—	14	14
30	13.5	13	—	—	14	—
40	14	13	13	14	14	14.5
50	14	13	13.5	—	15	15
60	14	13	14	14	15	15
70	14	13	14	—	15	15
80	14	13	14	15	—	14.5
90	14	13	14	14.5	15	—
100	14	13	14	14.5	14.5	14
120	—	13	14.5	14.5	—	—
140	—	—	15	14.5	—	13.5
160	13	13	—	—	14	13.5
180	13	13	14.5	14.5	14	13.5
200	13	13	14.5	13.5	13.5	13.5

In instituting comparative measurements of curvature

we arrive at conclusions similar to those reached in our comparative measurements of pressure with the sinking and rising Hg. column. The comparative measurements of curvature are of little interest; and I therefore tabulate only three of these observations. Eye IV. retains its curvature 13, which it acquired with 20 mm. Hg.; the distended sclerotic does not contract in the least. The sclerotic of eye XIV. contracts but incompletely; with 40 mm. Hg., a amounts to $\frac{13}{20}$; b to $\frac{14}{20}$ mm. For reasons already mentioned, we disregard the first two measurements with 0 and 10. In case XV. the sclerotic contracts completely, but very slowly, with a comparatively low Hg. pressure. The other six eyeballs, upon which I made comparative measurements of curvature, yield essentially the same results.

Intraocular Pressure of Normal Eyes.—Being thus enabled to express, with the aid of our Table I., all tonometrical measurements in Hg. mm., we proceeded at once to determine the intraocular pressure of normal eyes. In examining the statements hitherto published on this subject by Weber, of Darmstadt, Dor, and Monnik, we perceived that the point in question was by no means definitely settled.

Weber found in his tonometrical measurements of about 50 living eyes an average value of 29°. He observed a physiological range of 14°, from 25 to 39. Weber, however, regards his average value as too high, and says as follows:* "If we consider that the application of the

* Arch. f. Ophth. XIII., 1, 209.

tonometer causes at times violent involuntary muscular contractions, which may raise the tension to 40–50°, if we furthermore consider that most of the values between 25° and 33° vary with a gradual increase of pressure, and that the high average can only be reached by suddenly increasing the pressure considerably without resorting to its intermediate degrees, we may undoubtedly be allowed to estimate the degree of normal tension of the sclerotic at 26–27° Ton., corresponding to a Hg. pressure of 30–40 mm. This value still exceeds the average found by palpation. By this method the average is generally estimated at 20–30 mm. Hg.; sometimes 30–40 mm. Hg. are considered normal." Thus, according to Weber, the range of physiological variations extends from 20–40 mm. Hg.

Dor obtained 27° To. = 37 mm. Hg., as the average value of intraocular pressure.* Since he, however, measured the eyes according to his old method, we may, a priori, state that his tonometrical values are too high.

Monnik, in his last monograph, "a new tonometer and its use,"† speaks of the normal intraocular pressure as follows: "The limit of normal and morbidly altered tension is probably not the same for every eye, and cannot be accurately determined for one particular eye." He designates those eyes as normal, in which a pressure of 10–15° is requisite to cause a depression of ¼ mm. Unfortunately, Monnik's results are not comparable with ours, since they cannot be commuted into Hg. mm. Monnik's obser-

* Arch. f. Ophth. XIV., 1, 25.

† Arch. f. Ophth. XVI., 1, 72.

vations as to the decided influence of age upon the tension of the globe were of particular interest to me, since I had also noticed this relation in the very biennging of my experiments. He states that, in order to obtain a depression of ¼ mm.,

At the age of 10–20, 20–40, 40–60 years, an average pressure of 12°, 12.5° 14.6° is required.

Monnik guardedly adds that the number of his observations is too small to establish the constancy of that influence.

In order to solve this question at least approximatively, I measured about 100 normal living eyes. The results of these measurements are recorded on Table V., and grouped together according to their tonometrical values.

TABLE V.

Tonometrical examinations of 102 *normal human eyes.*

(Curvatures measured in $\frac{1}{20}$ mm.)

No.		Curv.	To.°.
1	Ryf, Christian, 12 y., O. s.	19	22
2	Bösch, Joh., 8 y., O. s.	18	22.5
3	Mai, Adolf, 16 y., O. d.	15.5	22.5
4	Jacob, Fried., 21 y., O. d. Recovering from typhoid fever.	14	22.5
5	Id. O. s.	14.5	22.5
6	Jaggi, M., 22 y., O. d. Recovering from typhoid fever.	15	22.5
7	Id. O. s	15	22.5
8	Messerli, Marie, 5 y., O. d.	18	23
9	Zingg, Rosina, 7 y., O. d.	17.5	23
10	Bigler, Marie, 7 y., O. s.	15	23
11	Schmied, Emil, 22 y., O. d.	16	23
12	Bieri, Christ., 13 y., O. d.	15.5	23
13	Amstutz, Marie, 17 y., O. s.	16	23
14	Laurenti, Otto, 20 y., O. d.	15	23

No.		Curv.	To.°.
15	Matthys, Jak., 21 y., O. d.	14	23
16	Moser, Gottfried, 23 y., O. d.	15	23
17	Id. O. s	15	23
18	Streit, Chr., 24 y., O. s.	13	23
19	Müller, Fried., 23 y., O. d. Recovering from typhoid fever.	14.5	23
20	Id. O. s.	15	23
21	Mosimann, S., 41 y., O. d. Perichondritis laryngea	15	23
22	Grimm, Chr., 66 y., O. d. Leucæmia	16	23
23	Id. O. s.	15	23
24	Bigler, Marie, 11 y., O. d.	15	23.5
25	Liechti, Jacob, 15 y., O. d.	18	23.5
26	Begeler, Rud., 22 y., O. d	14	23.5
27	Id. O. s.	14	23.5
28	Streit, Christ., 24 y., O. d.	13	23.5
29	Gerber, Christ., 10 y., O. s	14.5	24
30	Koller, Lina, 10 y., O. d.	17	24
31	Ead. O. s.	17	24
32	Bieri, Christ., 13 y., O. s	15.5	24
33	Mai, Adolf, 16 y., O. s.	16	24
34	Hofer, Joh., 17 y., O. d	16.5	24
35	Amstutz, M., 17 y., O. d. (O. s. No. 13.)	14	24
36	Flückiger, Andreas, 20 y., O. d.	14	24
37	Id. O. s	14	24
38	Lehmann, Christ., 21 y., O. s.	13.5	24
39	Hodel, Marie, 22 y., O. d	14	24
40	Brechbühl, Ulrich, 26 y., O. d.	14	24
41	Friedrich, Christ., 30 y., O. d.	16	24
42	Kohler, Marie, 30 y., O. d.	14	24
43	Ead. O. s.	14	24
44	Zwahlen, Christ., 35 y., O. d.	16.5	24
45	Sorgen, Joh., 35 y., O. d.	14.5	24
46	Id. O. s	14.5	24
47	Marg, Simon, 35 y., O. s.	14	24
48	Stucki, Friedr., 44 y., O. s.	15	24
49	Rüfenacht, Magdal., 55 y., O. d.	14	24
50	Burri, Anna, 25 y., O. d.	18	24.5
51	Ead O. s	18	24.5
52	Kummer, Jacob, 18 y., O. d.	13.5	24.5
53	Dreier, Anna, 24 y., O. d.	14.5	24.5
54	Ead. O. s	15	24.5
55	Sommer, Anna, 40 y., O. d	15	24.5
56	Ead. O. s.	15	24.5
57	Rüfenacht, Magdal, 55 y., O. s. (O. d.=No. 49.)	14	24.5
58	Niklaus, Gottfried, 30 y., O. d.	15	24.5
59	Id. O. s.	15	24.5
60	Biedermann, Gottfr., 14 y., O. s.	14	25
61	Matthys, Jacob, 21 y., O. s. (O. d., No. 15).	14	25
62	Hodel, Marie, 22 y., O. d.	14.5	25
63	Brechbühl, Ulrich, 26 y., O. s.	14.5	25
64	Jost, Elizabeth, 28 y., O. s.	14	25
65	Stoller, Marg., 31 y., O. d	14.5	25
66	Ead. O. s.	15	25
67	Keller Joh., 38 y., O. d.	12.5	25

No.		Curv.	To.°.
68	Zaugg, Joh., 38 y., O. s.	13	25
69	Röschli, Mrs., 40 y., O. d.	17	25
70	Stucki, Friedr., 44 y., O. d	14	25
71	Siegerist, Mrs., 50 y., O. d.	15.5	25
72	Aeschbach, Abraham, 51 y., O. d.	15	25
73	Weiermann, Joh., 55 y., O. d.	15	25
74	Kunz, Samuel, 57 y., O. d	16	25
75	Bächler, Rud., 64 y., O. d.	13.5	25
76	Id. O. s.	14	25
77	Zehnder, Joh., 71 y., O. d.	13	25
78	Hiltbrunner, Gottfr., 35 y., O. s.	15	25.5
79	Keller, Joh., 38 y., O. s. (O. d.=No. 67.)	13.5	25.5
80	Röschli, Mrs., 40 y., O. s. (O. d.=No. 69.)	16	25.5
81	Rolli, Samuel, 41 y., O. d.	12	25.5
82	Id. O. s	12	25.5
83	Frei, Maria, 50 y., O. d.	16	25.5
84	Ead. O. s.	15	25.5
85	Kunz, Samuel, 57 y., O. s	16	25.5
86	Stucki, Joh., 63 y., O. s.	14	25.5
87	Jonas, Nicolaus, 64 y.	15	25.5
88	Zehnder, Joh., 71 y., O. d. (O. s.=No. 77.)	13	25.5
89	Hiltbrunner, Gottfr., 35 y., O. d. (O. s.=No. 78.)	15	26
90	Ulrich, Jacob, 41 y., O. s.	14	26
91	Zaugg, Joh., 38 y., O. d.	15	26
92	Feller, David, 54 y., O. d	17	26
93	Friedli, Friedr., 58 y., O. d.	13	26
94	Christen, Nicol., 58 y., O. s.	13	26
95	Siegerist, Mrs., 50 y. (O. d.=No. 71.)	15	26
96	Krebs, Anna, 60 y., O. s.	15	26
97	Stucki, Joh., 63 y., O. d. (O. s.=No. 86.)	13.5	26
98	Friedli, Friedr., 58 y., O. s. (O. d.=No. 93.)	13	26.5
99	Jonas, Nicolaus, 64 y., O. d. (O. s.=No. 87.)	14	26.5
100	Bohnenblust, Rud., 72 y., O. d.	12.5	26.5
101	Christen, Nikol, 58 y., O. s. (O. d.=No. 94.)	12.5	27
102	Bohnenblust, Rud., 72 y., O. s. (O. d.=No. 100.)	12	27

Summing up all these observations we obtain, with variations of 5° To. = 30–70 Hg. mm., an average value of 24.5° To. = 50 mm. Hg. for the normal eye. Tonometrically our average is smaller than Dor's, but requires the higher equivalent, Hg. column, of 50 mm. instead of 37 mm. Our results bear a similar relation to Weber's, who likewise employed the weight of the instrument as

a constant. Weber is inclined to estimate the average tension of normal eyes at 26–27° To., or even less, viz.: 20–30 mm. Hg. Still we have no reason to doubt our results, since they are based upon more extensive observations, and exhibit only variations of 5° To., and not of 14.

The influence of age upon the tension of the globe is so striking that an investigation of this correlation, for the sake of determining the range of physiological variations for the different periods of life, appeared to us of greater importance than the computation of a general average value.

For the sake of clearness we arranged in Table VI. the tonometrical values according to age. The second row contains the Hg. pressure (see Table I.), corresponding to the tonometrical degrees of the first row.

TABLE VI.

TENSION.		Number of Observations.	AGE.			
To.°	Hg. mm.		Under 25 years.	25–45 years.	45–65 years.	Over 65 years.
22	30	1	1	..	..	..
22.5	37	6	6	..	..	..
23	39	16	13	3	..	..
23.5	40	5	5	..	..	..
24	46	21	11	9	1	..
24.5	49	10	3	6	1	..
25	52	18	3	8	6	1
25.5	54	14	..	5	5	1
26	60	9	..	3	6	..
26.5	66	3	..	..	2	1
27	70	2	..	..	1	1

The three eyes of 25–45 years with a tension of 23° To. belong to persons whose state of nutrition was abnormally bad, and in whom the pressure of the blood was very low. Mosimann, Joh., had been attacked three weeks previous to the measurement with very severe perichondritis laryngea, and saved from suffocation by a speedy tracheotomy. Grimm, Joh., No. 22, suffered from extensive leucæmic swelling of all lymphatic glands; his eyes were intact. I therefore think that, in drawing our conclusions from Table VI., we may justly disregard the three eyes of persons whose general tone was abnormally low at the time of measurement.

From the foregoing table we learn:—

That a tension of 22–23.5° To. is commonly observed in eyes under 25 years; a tension of 24–24.5° at every age up to 65 years, and as frequently under 25 as between 25 and 45 years, but very seldom over 45 years. Of the cases under 25 years of age, 17 per cent. showed a tension of 25°; the remaining 83 per cent. are nearly equally distributed among the cases of 25–45, and over 45 years of age. A tension of 25.5° To. was observed exclusively in cases over 25 years of age, and found to be equally frequent in cases of 25–45, and over 45 years of age. A tension of 26° was observed in double the number of cases over 45 years, as between 25–45 years. Degrees of tension of 26.5 and 27 were observed exclusively in cases over 45 years.

Summary of our analysis:—

First: The normal tension of eyes under 25 years

varies commonly between 22.5 and 24° To. = 27–46 mm. Hg. Variations of 22–25° To. = 30–54 mm. Hg., are still within the range of physiological tension. We may consider 23° To. = 40 mm. Hg. as the average value.

Secondly: Eyes between 25 and 45 years possess an average tension of 25° To. = 52 mm. Hg., with a physiological range of 24–26° To. = 40–60 mm. Hg.

Thirdly: Eyes between 45 and 65 years possess an average tension of 25.5 To.° = 54 mm. Hg., with a physiological range of 24–27° To. = 46–70 mm. Hg.

Fourthly: The physiological tension of eyes above 65 years, varies between 25° and 27° To. =52–70 mm. Hg., with an average value of 26° To. = 60–64 mm. Hg.

Thus we obtain the following results :—

Under	25	years an average of	23° To.	=	40 mm.	Hg.
Between	25 and 45	years "	25°	=	52	
"	45 and 65	" "	25.5°	=	54	
Over	65	" "	26°		60	

which show that the normal intraocular pressure increases with age.

EFFECT OF ATROPINE.

Several years ago, A. v. Graefe made the clinical observation that atropine diminishes the intraocular pressure. This has been confirmed by various authors. A discrepancy of opinion, however, prevails as to the degree of diminution caused by atropine. Dor* observed a constant diminution of pressure of 1–3° To.

* Arch. f. Ophth., XIV., 1, 45.

Weber* states that in some cases he found a diminution of 10–14° To. This result becomes intelligible only, if, instead of 10–14° To., we are permitted to read 10–14 mm. Hg. In his paper: "Over den Invloed van Atropine op de intraoculaire Drukking," † Adamük estimates the maximum diminution of intraocular pressure caused by atropine at 6 mm. Hg. Stellwag von Carion ‡ strenuously declared that manometrical experiments prove absolutely nothing in regard to the direct influence of mydriatics and myotics upon the intraocular pressure. "The autonomy of the inner current and the stability of the intraocular quantity of blood become annulled by the opening of the capsule. The ciliary muscle gains a greater influence upon the tension of the sclerotic." Stellwag furthermore says, that tonometrical experiments solely may yield a proof of the direct influence of those agents upon the degree of intraocular pressure. Stimulated by Stellwag's view, we instituted a series of experiments with Dor's tonometer, in order to determine the effect of atropine. With the exception of two cases, examined at different periods, the thirty-six cases recorded on Table VII. are arranged according to the intensity of the effect caused by the instillation of atropine. We generally used 1–2 drops of a iv. gr. ad ℥j. solution.

* Arch. f. Ophth., XIII., 1, 250.

† Physiolog. Laborator. v. Utrecht, 70.

‡ Der intraoculäre Druck und die Innervationsverhältnisse der Iris: 1868.

TABLE VII.

Tonometrical observations with regard to the influence of atropine upon intraocular pressure.

No.		Curv.	Tens. Ante Atrop.	Tens. Post Atrop.
1	Tschanz, Anna, O. s. Cataracta diabet.	15	26	26.5
2	Ead. O. d. Cataracta diabet.	14	26	26
3	Friedli, Friedr., O. s., normal.	15	24	24
4	Lehmann, Christ., O. s., normal.	13.5	24	....
	1 hour after instillat. of Atrop.	....	....	24
5	Kunz, Samuel, O. d., normal.	16	26.5	26.5
6	Mai, Adolf, O. s., normal.	16	24	24
7	Niklaus, Gottfried, O. d., normal.	15	24.5	24
8	Emm, M., O. d. Atrophia nerv. opt.	18	23	22.5
9	Brechbühl, Ulrich, O. d., normal.	14	24	23.5
10	Wittmer, Christ., O. s., normal.	14	23	22.5
11	Flückiger, Andreas, O. d., normal.	14	24	23.5
12	Bosch, Joh., O. s., normal.	18	22.5	....
	24 hours after instill.	....	....	22
13	Koller, Lina, O. d., normal.	17	24	23.5
14	Hiltbrunner, Gottfried, O. d., normal.	15	25.5	25
15	Zehnder, Joseph, O. s., normal.	13	25.5	25
16	Büfenacht, M., O. d., normal.	14	24	23.5
17	Frei, Marie, O. d., normal.	16	25.5	24.5
18	Ead. O. s., normal.	15	25.5	24.5
19	Detten, Elizab., O. s. Iritis.	19	25	24
20	Ueltschi, Henriette, O. s. Cataract. moll.	17	25	24
21	Burri, Anna, O. s., normal.	18	24.5	....
	1 hour after instill.	....	....	24
	24 hours " "	....	....	23.5
22	Zingg, Rosina, O. d., normal.	17.5	23	....
	½ hour after instill.	....	....	23
	24 hours " "	....	....	22
23	Ryf, Christ., O. s., normal.	19	22	....
	24 hours after instill.	....	....	21
24	Bickel, Carl, O. s. Old Retino-choroid.	15	25.5	....
	24 hours after instill.	....	....	24.5
25	Id. O. d. Old Retino-choroid	16	24.5	....
	24 hours after instill.	....	....	23.5
26	Zwahlen, Christ., O. s., normal.	16.5	23	22
27	Aeschbach, Abrah., O. d., normal.	15	25	24
28	Detten, Elizab., O. d. Iritis.	19	24.5	23
29	Leuenberger, Joh., O. d., normal.	18	24.5	23
30	Nussbaum, Christ., O. d., normal.	17	25	23.5
31	Marti, Elizab., O. d., normal.	14.5	27	25.5
32	Ueltschi, Henriette, O. d. Cataract. moll.	....	25	....
	48 hours after instill.	17	....	23
33	Nussbaum, Christ., O. s., normal.	18	24.5	22.5
34	Zwahlen, Joh., O. d., normal.	17.5	25	53
35	Id. O. s., normal.	17.5	25	23
36	Dreier, Anna, O. s.	14.5	24.5	22.5

If, in accordance with Table I., we estimate the range of extreme physiological variations of intraocular pressure at an average value of 0.5° To. = 6 mm. Hg., we derive from the foregoing observations

TABLE VIII.

Number of cases in	Number of observ'd per cent.		To. °	mm. Hg.
1	3	Atropine caused an increase of pressure of.......	0.5	6
6	16	" " " " " of.......	.0	0
11	29	" " diminution " of.......	0.5	6
11	29	" " "	1	12
4	10	" " "	1.5	18
5	13	" " "	2	24

We were very much surprised at the unexpected result obtained in the first case, and very carefully repeated the measurement several times, but always with the same effect. As, however, this case is unique in the series of our experiments, and the increase of pressure insignificant, I am inclined to question its validity, and to ascribe these 0.5° To. to unavoidable sources of error. In two cases *Monnik observed an increase of intraocular pressure after atropine, but both cases were complicated with posterior synechiæ.*

Here, the stretching of the synechiæ by atropine may have caused an abnormal irritation of the trigeminus, which resulted in an increase of intraocular pressure. A. v. G. Graefe mentions cases of chronic glaucoma, in which an acute attack supervened after the instillation

of atropine. May we not explain this by assuming that, in many cases of glaucoma, the fifth nerve is in an abnormally irritable condition, and reacts in an anomalous manner upon the excitation by atropine?

In our case 1 the ordinary instillation of atropine caused a regular, but moderate, by no means maximum, dilatation of the pupil. *In fully* 80 *per cent. of our cases we observed a diminution of intraocular pressure* amounting, in the majority of cases, to 0.5–1° To.=6–12 mm. Hg. This result corresponds best with Dor's observations.

The degree of diminution of intraocular pressure seems to depend greatly upon the length of time the atropine is allowed to act. On this point our observations are, unfortunately, somewhat inaccurate, because we neglected to take notice of it in the beginning. In case 22 no effect was manifest a quarter of an hour after the instillation, though the pupil was fully dilated, while twenty-four hours later the tension had decreased 1° To. In case 21 we observed a diminution of tension of 0.5° after the first hour, but of 1° To. after twenty-four hours. Before our attention had been directed to this point we often made the second measurement ½–1 hour after the instillation. This, perhaps, partially explains why, in six cases, we found no diminution of pressure. We may summarily state, *first, that the effect of atropine to diminish the intraocular pressure has been tonometrically demonstrated in the majority of cases; secondly, that its effect to increase the pressure of*

eyes without glaucoma or iridic adhesions is highly questionable; thirdly, that its effect does not become manifest in a small number of cases.

INFLUENCE OF IRIDECTOMY UPON INTRAOCULAR PRESSURE.

There are but very few observations on record as to the influence of iridectomy upon intraocular pressure, measured with either the tonometer or manometer. In accordance with his former experiments, Dor estimated the diminution of pressure by iridectomy, eight days after the operation, at 5° To. on an average. Hippel and Grünhagen* investigated the subject manometrically on normal animal eyes. In their four published experiments the diminution of pressure varies between 4 and 19 mm. Hg., yielding an average of 12.5 mm. They excised at least one-sixth of the iris, and made the second measurement after several days, when the wound was nearly cicatrized. In the following table we group together several tonometrical observations, made chiefly by Dor, at the clinic in Bern, according to the other method of measurement (—10 denotes a pressure below 10, which cannot be measured accurately with the tonometer.)

*Arch. f. Ophth. XIV. 1, 44.

TABLE IX.

Tonometrical observations on the influence of iridectomy upon intraocular pressure.

No.		Curv.	Tens. Ante irid.	Tens. Post irid.
1	Gerber, Ulr., 65 y., O. d. Cataract irit. plast......	15	28.5	....
	Immediately after irid........	....	....	—10
	6 days " "	....	....	24.5
2	Sommer, A., 75 y., O. d. Glaucoma........	15	27.5	....
	6 days after irid........	....	....	26
3	Ead. O. s........	14	29	....
	8 days after irid........	....	....	26.5
4	Feller, David, 54 y., O. s. Glaucoma........	17	27	....
	8 days after irid........	....	....	26
5	Hirschi, Eliz., 59 y., O. s. Glaucoma........	19	26	....
	11 days after irid........	....	....	23
6	Ead. O. d. Glaucoma........	19	27	....
	7 weeks after irid........	....	....	24.5
7	Franz, J., 20 y., O. s. Glaucom. secund. Pannus..	17	30	....
	9 days after irid........	....	....	19
8	Id. O. d. Leucom. Pannus........	18	27	....
	9 days after irid........	....	....	16
9	Detten, Eliz., 25 y., O. s. Iritis........	19	25	....
	Immediately after irid........	....	....	—10
	3 days " "	....	....	19.5
	10 days " "	....	....	20.5
10	Ead. O. d. Iritis........	19	24.5	....
	Immediately after irid........	....	....	—10
	3 days " "	....	....	20
	10 days " "	....	....	20
11	Wenger, Kath., 57 y., O. d. Irido-choroiditis......	18	24.5	....
	2 days after irid........	....	....	16
	8 " " "	....	....	22
12	Ead. O. s. Irido-choroid........	18	23	....
	2 days after irid........	....	....	11
	8 " " "	....	....	21.5
13	Imhoof, Jac., 46 y., O. d. Glaucoma........	15	30	....
	9 days after irid........	....	....	28
14	Id. O. s. Glaucoma. Synech. post.	16	29	....
	9 days after irid........	....	....	25.5
15	South, Charles, 54 y., Glaucoma. O. d........	13	30.5	....
	8 days after irid........	....	....	27.5

The two eyes (7 and 8) affected with secondary glaucoma, consequent upon corneal disease, show, nine days

after the operation, an abnormally low intraocular pressure, their tension being 11° To. lower than before the operation. If, in computing the average, we add those two eyes, we obtain after six or more days subsequent to the iridectomy, a diminution of intraocular pressure of about 4° To.=48 mm. Hg.

If we disregard the eyes 7 and 8 as exceptional, we obtain an average value of 2.8° To. = 33 mm. Hg.

Thus our results differ from those of the above-named observers and hold an intermediate place. Even our lower average of 33 mm. Hg. exceeds more than twice the average obtained by Hippel and Grünhagen in their experiments. This discrepancy may be explained by the fact that these observers experimented upon the normal eyes of small animals, while our measurements were made on human eyes, the tension of which was in the majority of cases pathologically increased.

PATHOLOGICAL EYES.

Our last essentially practical section contains a table of tonometrical measurements of 108 pathological eyes. These we did not group together according to the different forms of disease, but according to the values of tension. Though it was our aim to include a great variety of diseases, yet we directed our attention chiefly to cases of glaucoma. For the sake of completeness we recorded the curvatures of all the cases in twentieths of a millimetre.

TABLE X.

Tonometrical examinations of 108 *pathological human eyes.*

No.		Curv.	To.
1	Klaefiger, Gottl., 13 y., O. s. Phthisis bulbi after Irido-choroid	18	—10
2	Idem. O. d. Hyaloiditis purulenta	18	13
3	Liechti, Jacob, 15 y., O. d. Phthisis bulbi after cyclitis O. s., normal To. = 23.5	17	13
4	Jost, Elizab., 28 y., O. d. Phthisis bulbi incipiens after cataracta traumatica with synechia post	8	14
5	N. N., O. s., Sclero-irido-choroiditis, synech. post. Pupil partly covered by plastic exudation. Sees hands of watch distinctly	13	14
6	Perillaz, Henriette, 58 y., O. s. Iritis sympathica Cataracta	17	16
7	Mann, H., 61 y., O. s. Phthisis after injury. Large anterior scleral staphyloma. S. = O	13	16
8	Butcher, William, 45 y., O. d. Iridectomy performed one month ago, on account of iritis and hypopion-keratitis. S. = $\frac{4}{200}$	15	16
9	Waldmann, Samuel, 30 y., O. d. Phthisis bulbi after cyclitis	17	16.5
10	Hemphraire, James, 26 y., O. s. Myop. $\frac{1}{6}$. Large post. Staphyloma. Solutio retinæ	15	17
11	Hobbs, Marie, 40 y., O. d. Old irido-choroiditis. Iridectomy 6 and 2 years ago. S. quantit	13	18
12	Groslégier, Jean, 30 y., O s. Hydrophthalmus congenitus lens shrunk, iritic adhesions. S. $\frac{1}{80}$	17	18
13	Riesen, Samuel, 39 y., O. d Iritis sympath. cataracta. S. quantit	13	21
14	Mosimann, Joh., 15 y., O. d. Cicatrix corneæ after injury; synech. ant	14.5	21.5
15	Burk, Marie, 17 y., O. s. Old irido-chorioiditis. Iridectomy 8 months ago. Lens somewhat opaque since 2 weeks. (O. d., norm. To. 24)	15.5	21.5
16	Brager, Joseph, 45 y., O. s. Detachment of lower half of retina. Large, irregular posterior staphyloma and choroiditis atrophica. Counts fingers in 3′	14	21
17	Levi, Samuel, 23 y., O. d. Had formerly kerato-iritis syphil. (Lues. congen.). Pupil somewhat and irregularly dilated by atropine	14.5	22
18	Wüthrich, Christ., 35 y. Morbus Basedowii. Excessive protrusion of both eyes; lids cannot be closed; O. d. S. = $\frac{10}{200}$. Keratitis ulcerosa	17	22
19	Brager, Joseph (No. 16), O. d. Myopia $\frac{1}{4}$. Large sickle-shaped post, staphyl	14	22.5
20	Rindlisbacher, Christ., 75 y., O. s. Iritis sympath	15	22.5

No.		Curv.	To.
21	Wenger, Catharine, 37 y., O. s. Irido-choroiditis.........	18	23
22	Leuenberger, Abraham, 15 y. Atrophia alba.............	18	23
23	Zwahlen, Christ., 36 y., O. s. Paralysis of all the branches of the N. oculo-motor, s., excepting the ciliary branch. Paralys. trigem. sin. S. norm......................	16.5	23
24	Locher, Anna, 29 y., O. s. Solutio retin. Visual field almost entirely wanting; eccentrically in a very small spot. S. = $\frac{3}{200}$. After puncture of the retro-retinal exudation To. 19...........................	19	23
25	Siegenthaler, Joh., 47 y. Trauma bulbi, luxatio lentis; rupture of iris; extravasation of blood into ant. chamber, vitreous body and retina.....................	13.5	23
26	Grimm, Christ., 66 y., O. d. Cataracta incipiens. Leucæmia..	14	23
27	Mischler, Anna, 55 y., O. d. Synechia post.............	16	23.5
28	Bälli, Anna, 22 y., O. s. Cataracta diabet. Hyp. $\frac{1}{24}$.....	18	23.5
29	Seiler, Friedr., 27 y., O. s. Hemeralopia; with the ophthalmoscope no changes visible. Visual field complete.	16	23.5
30	Smith, Alfred, 16 y., O. d. Cataract. moll. Strabismus diverg..	14	23.5
31	Mischler, Anna (No. 27), O. s. Synech. post.; obscurat. corp. vitr..	15	24
32	Seiler, Friedr. (No. 29), O. d..........................	16	24
33	Mürner, Peter, 30 y., O. s. Old traumatic luxation of lens; synech. poster. S. = quantit.................	15	24
34	Bickel, Karl, 56 y., O. d. Old choroidit. with plastic exudat...	17	24.5
35	Nussbaum, Christ., 37 y., O. s. Retinitis pigment........	17	24.5
36	Wenger, Cathar. (No. 21), O. d. Irido-choroiditis........	18	24.5
37	Waldmann, Samuel, 30 y. (No. 9), O. s. Iritis sympath...	14	25
38	Weber, Joh., 42 y., O. s. Atroph. nerv. opt.............	19	25
39	Rindlisbacher, Christ., 75 y. (No. 20), O. d. Luxatio lentis...	13	25
40	Detten, Elizabeth, O. s. Iritis.........................	19	25
41	Ueltschi, Henriette, 45 y., O. s. Cataracta.............	17	25
42	Ead. O. d. Cataracta..............	17	25
43	Zwahlen, Joh., 54 y., O. d. Atroph. nerv. opt. S. quantit.	17.5	25
44	Id. O. s. Id.	17.5	25
45	Groslégier, Jean, 30 y. (No. 12). Hydrophth. cong., O. d. Lens slightly dislocated. S. quantit...............	17	25
46	Nussbaum, Christ., 32 y. (No. 35), O. d. Retin. pigment.	17	25
47	Rainbow, Henry, 56 y., O. s. 17 months ago, iridectomy on account of glaucoma. Visual field limited towards nose. Reads Sn. 6..................................	13	25
48	Philipp, Thomas, 60 y., O. s. Almost complete paralysis of all the recti muscles since two weeks (O. d. norm. To. 25)...	16	25
49	Levi, Samuel, 23 y. (No. 17), O. s. Old kerato-iritis syphilit, occlusio pupillæ...........................	15	25.5
50	Bickel, Karl, 56 y. (No. 34), O. s. Choroidit. plast. with obscurat. of corp. vitr	16	25.5
51	Foge, James, 51 y., O. s. Aphakia after linear extraction. S. = $\frac{2}{200}$..	14	26

No.		Curv.	To.
52	West, William, 73 y., O. s. Synech. ant., occlusio pup.	13	26
53	Hemphraire, James, 26 y. (No. 10). Od. myop. $\frac{1}{4}$.	14.5	26
54	Hawkins, Mary, 42 y., O. d. Spontan. detachm. of lower half of retina since 5 weeks. In upper half of visual field S. = O, counts fingers in lower half (O. s., norm. To. 23).	15	26
55	Tschanz, Anna, 44 y., O. d. Cataract. diabet.	14	26
56	Ead. O. s. " "	14	26
57	Möri, Elizab., 58 y., O. s. Cataracta matura.	15	26
58	Hirschi, Elizab., 59 y., O. s. Glaucom. chron.	19	26
59	Mäder, Samuel, 34 y., O. s. Synech. post.	19	26
60	Weber, Joh., 41 y. (No. 38), O. d. Atroph. nerv. opt.	19	26
61	Wüthrich, Christ., 35 y. (No. 18), O. s. Morb. Basedowii. S. = $\frac{5}{200}$.	17	26
62	Borlat, Susanne, 54 y., O. d. Glaucoma.	19	26.5
63	Ead. O. s. "	18	26.5
64	N. N., O. s. Glaucoma and cataracta incipiens. S. quantit	13	26.5
65	Javener, William, 44 y., O. d. Hypopion keratitis favorably progressing; post. synech. (O. s., norm., To. 27). Patient pressed violently.	15	27
66	Carpenter, Elizab., 45 y., O. s. Acute glaucoma.	13	27
67	Möri, Elizabeth, 58 y., O. d. Aphakia, 3 years after couching	13	27
68	Feller, David, 54 y., O. s. Glaucoma.	17	27
69	Hirschi, Elizab., 59 y. (No. 58). Glauc. chron.	19	27
70	Franz, Joseph, 20 y., O. d. Staphyloma corneæ. Glauc. secund.	18.5	27
71	Gerber, Ulrich, O. d. Cataracta pigmentosa. Brown and blackish-brown pigment is deposited in the cataractous lens, especially in its peripheral parts.	15	27.5
72	Stettler, Marie, O. d. Cataracta.	13.5	27
73	Ead. O. s.	15	27.5
74	Sommer, Anna, 75 y., O. d. Glaucoma. S. = $\frac{1}{40}$.	15	27.5
75	Aeschbach, Abraham, 51 y., O. s. Cataract. secundar. 5 months after extraction (Graefe) of traumatic cataract (O. d., norm., To. 25).	14	27.5
76	Marti, Elizab., 50 y., O. d. Choroid. serosa, staphyl. post. S. = $\frac{10}{40}$.	14	27.5
77	Ead. O. s. Choroiditis serosa, staphyl. post	15	28
78	Carpenter, Elizab., 45 y. (No. 66), O. d. Iridectomy 2 months ago on account of glaucoma. S. quant.	14	28
79	Lewell, John, 68 y., O. s. Glaucoma chronic.	16	28
80	Hunt, Sarah, 23 y., O. d. High degree of myopia. Glaucoma chron. Visual field somewhat limited. Sees hands of watch.	15	28
81	N. N. (No. 64), O. d. Glaucoma. S. = $\frac{2}{200}$.	13	28
82	Mann, H., 61 y. (No. 7), O. d. Myopia $\frac{1}{4}$. Very large, irregular, post. staphyloma. Visual field contracted below and inward.	13.5	28
83	Boilat, 52 y., O. d. Chorio-retinitis. Complete atrophy of opt. nerv. and retina; extensive yellow plastic exudations; choroidal pigment macerated and grouped in dense clusters. S. quantit.	14.5	28

No.		Curv.	To.
84	Schild, Niklaus, 60 y., O. d. Glauc. chron.	19	28
85	Ritz, Joseph, 64 y., O. s. Atroph. nerv. opt. S. = O.	15	28
86	Id. O. d. " " " S. = quantit.	15	28
87	Gerber, Ulrich, 65 y. (No. 71), O. s. Cataract. pigment.	15	28.5
88	Jones, John, 42 y., O. s. Sarcoma choroideæ	16	28.5
89	Imhof, Jacob, 46 y., O. s. Synechiæ post, glauc. secund. chron. Visual field somewhat contracted. S. = $\frac{15}{50}$.	16	29
90	Sommer, Anna, 75 y. (No. 72), O. s. Glaucoma chron. S. = $\frac{1}{15}$.	13	29
91	Boilat, Augustin, 52 y. (No. 83), O. s. Condit. same as O. d. S. quant	13	29
92	Rohrbach, Marie, 55 y., O. s. Glaucoma chron. S. = $\frac{2}{30}$.	18	29
93	Imhof, Jacob, 46 y. (No. 89), O. d. Many post. synechiæ. Secondary glaucoma. S. quantit.	15	30
94	Franz, Joseph, 20 y. (No. 70), O. s. Leucoma, glaucoma.	17	30
95	Delpech, François, 25 y., O. s. Glaucoma	19	30
96	Id. O. d.	19	30
97	Coles, Thomas, 50 y., O. s. Glaucoma, iridectomy two months ago. Reads Jäg. 6.	13.5	30
98	Thomson, William, O. s. Glauc. chron. Iridectomy 2 months ago after an acute attack; iris caught in outer corner of wound	16	30
99	Napper, George, 36 y., O. d. Keratoconus. Old multiple post. synechiæ. On the lower half of cornea a highly vascularized leucoma. S. quantit. Patient states that 9 years ago he suffered from a violent inflammation of this eye, which 7 years ago he injured with a fish-bone. Cornea O. s. normally curved; small macula	14.5	30
100	South, Charles, 53 y., O. d. Glaucoma inflammat. S. = O. Reads Jäg. 3. Cataracta incipiens	13	30.5
101	Rainbow, Henry, 56 y. (No. 47). Glaucoma absolutum since 9 years. S. = O.	12.5	30.5
102	Rohrbach, Marie, 55 y. Glaucoma. S. = O.	17	30.5
103	Warren, Alfred, 20 y., O. d. Iritis sympathica. Occlusio pupillæ. Iris degenerated and projecting into anterior chamber. O. s. was enucleated some time ago	15	32
104	Dickens, Marie, 68 y., O. s. Glaucoma chronicum. S. = O.	13	33
105	Schild, Niklaus, 60 y. (No. 84), O. s. Glaucoma chronicum and cataract	19	33
106	South, Charles, 54 y. (No. 100), O. s. Glaucoma absolutum. Cataract. S. = O.	12.5	36
107	Coles, Thomas, 50 y. (No. 97), O. d. Glaucoma. S. quantitat. in the upper and outer quadrant. Iridectomy 2 months ago	13	36.5
	ADDITIONAL CASE.		
108	Watt, Emily, 8 y., O. d. Hyaloiditis plastica	17	16

If we follow Dor, and arrange the measured eyes according to their relation to the normal pressure, into three groups, we obtain:

1. Eyes with diminished tension:

   $T \angle 22°$ To. $= \angle 30$ mm. Hg. Cases 1–17 and 108.

2. Eyes with normal tension:

   $T = 22–27°$ To. $= 30–70$ mm. Hg. Cases 17–70.

3. Eyes with increased tension:

   $T > 27°$ To. $= > 70$ mm. Hg. Cases 71–107.

This division is obviously not very precise; first, because our limits of the physiological range of normal tension may, possibly, not represent the extreme limits; and secondly, because these limits shift with advancing age. If we consider the age in cases 19 and 20, the tension of 22.5° To. must be regarded as diminished, and conversely, the tension of 26.5° To. pathologically increased in case 62, since all the other symptoms leave no doubt as to the nature of the disease.

In such doubtful cases it is of the greatest importance to compare the affected eye with the other normal eye.

On the whole, our measurements confirm the results obtained by Dor, and correspond, in the main, with Monnik's statements. I shall, therefore, dwell more explicitly on several special cases of particular interest, and comment upon certain points, which have either not yet been sufficiently investigated, or in which I differ from the above-named experimenters.

Dor lays particular stress upon a case of detachment of the retina, with indisputable increase of tension. This unusual phenomenon can be explained by assuming that there existed an intraocular tumor.

In my case 54 the detachment was indubitably not complicated with a tumor, and yet there existed an increase of tension. The patient, who had enjoyed normal sight up to five weeks ago, perceived suddenly, while taking up a glass of ale, that a dark veil obscured her right eye. Dr. Morgan, house-surgeon at Moorfields Hospital, asserted that in the initial stage of detachment of the retina he had, at times, observed an increase of tension, which subsequently always yielded to an abnormal softness. In our case I regard the tension of 26° To. as abnormally high, first, in consideration of the age, and secondly, in comparison with the left normal eye, the tension of which is 23° To.

The additional case of Hyaloiditis (108) was of special interest in a diagnostic point of view:

The patient presented herself at Moorfields in the beginning of March; after repeated examinations a non-malignant tumor was diagnosticated. The tonometer showed 16°. Guided by this abnormal diminution of tension, which could readily be recognized by palpation, I diagnosticated hyaloiditis. The eye, however, was enucleated, and several weeks subsequently shown to me opened. I beg leave to enter more fully into the details of this case.

Six months before the first examination the girl had begun to squint inwardly. The parents soon noticed that the squinting eye was totally blind. The girl, who looks feeble and haggard, never complained of pain; the eye never exhibited signs of inflammation. With lateral

illumination we could perceive, in apparently a short distance behind the lens, a dull, gray, concave surface, regularly smooth, without projections or depressions. Over this surface numerous vessels stretched, which in their arrangement and course showed no similarity to retinal vessels. They were undoubtedly newly formed vessels. The examination of the globe revealed that the hyaloid membrane was thickened in its whole extent, and changed into a yellowish-gray, rigid and coarse shell, anteriorly bounded by the lens, and containing the liquified vitreous body. On an average the thickening amounted to 1 mm., and in the region of the zonula Zinnii to 3 mm. The retina was in its place, and appeared microscopically unaltered. The shell consisted chiefly of small round cells.

This case reminded me in the beginning of the case of Klæfiger (1 and 2), observed at the clinic in Bern. The latter case had a somewhat different course; it was accompanied by very active inflammatory symptoms, which, in the case under consideration, must have been very slight, since they were not noticed by the parents. At the time of the enucleation not a trace of inflammation could be found. In the case of Klæfiger the product of inflammation was purulent, and yielded a yellowish-gray reflex; the eye was, therefore, not removed. In the case of Watt the product of inflammation was decidedly plastic. Both cases occurred in very juvenile persons.

The case Groslégier (12 and 45) was one of congenital hydrophthalmos in its worst form; in both eyes the anterior chambers were uncommonly deep, and the irides were shaking, in consequence of secondary changes in the lens. The tension of the right eye was far below the normal average (18° To.); the left eye showed an increase of tension (25° To.).

A similar relation exists in our only case of Morbus Basedowii (Wüthrich). In the right eye we note a

diminution of pressure (22° To.); in the left an increase (26° To.)

As regards the conditions of tension in cases of keratitis, iritis, and irido-choroiditis, we simply refer to Dor's* statements; in cases of synechiæ our results differ somewhat. We are obliged to emphasize this fact, since Monnik likewise maintains that eyes with posterior synechiæ are characterized by a diminution of tension. It is undoubtedly true that in a certain number of eyes with anterior or posterior synechiæ, we find a diminution of tension; this, we believe to be a sign of incipient phthisis (Dor). Other cases (52, 59, 89, 93) show an increase of tension; the more or less glaucomatous condition of such eyes we suppose to be due to the synechiæ, which are a source of constant irritation. Thus, we prove tonometrically that adhesions of the iris constitute an impending doom, remaining in the majority of cases, latent throughout life, but at times exerting an obnoxious influence even after many years, especially when in advanced age the disposition for glaucoma has increased.

Sympathetic iritis affects the intraocular pressure very much in the manner of common synechiæ. In the eyes 6, 13 (both complicated with cataract), and 20 the tension is diminished; in 103 it is increased to 32° To. Latterly I saw three other cases of secondary glaucoma consequent upon iritis, but in these I had no opportunity of applying the tonometer. The most marked of these

* Arch. f. Ophth. XVI. 1, 38.

three cases occurred in Guy's Hospital, London (Dr. Bader), in the person of a boy, aged fifteen, who had lost one eye from an injury; the tension, as estimated by palpation, amounted to 30° To.

In the case of old, plastic chorio-retinitis, with atrophy of the optic nerves, the increase of pressure is somewhat striking (83 and 91).

According to Monnik, highly myopic eyes show an increase of tension. In our measurements we found both extremes of the range of tension. In cases 10 and 16 we observe extensive posterior staphylomata, complicated with detachment of the retina; undoubtedly the detachments are due to the staphylomata. In case 19 (O. d. of Brager) we find M. $\frac{1}{6}$ with 22.5° To., a degree of tension below the normal average for the age of 45 years. Here we must apprehend that, as in 16 (O. s. of Brager), the disastrous detachment of the retina will supervene. Conversely, we find an increase of tension, viz., 28° To. in high degrees of myopia (53, 76, 77, 80, 82). This condition is certainly not accidental; it may be attributable to choroidal irritation.

We did not record cases of pure hypermetropia; they exhibit no anomalies of tension. In contradiction to "Myops" in "Miseries of a Myops,"* which considers the myopic eye as perfectly sound, the tonometer confirms the view of the defectiveness of the myopic and the soundness of the hypermetropic eye. The fact that "Myops" is able to read the smallest print with even

* *Medical Times and Gaz.*, Sept. 3, 1870.

a faint light, uninterruptedly and for long time, does not argue in the least against our statement. This symptom of myopia is well known and understood.

In our only case of keratoconus, we observed a considerable increase of tension (30° To.). This agrees with the observations of Von Graefe and Dor. The fact that a keratoconus, and not a corneal staphyloma, developed, shows that the increase of pressure was not due to the primary kerato-iritis, but that it supervened after the inflammatory symptoms had subsided and the cicatricial tissue had attained its natural consistency. It is most probable that the increase of pressure was caused by the very thick posterior synechiæ. This case illustrates very clearly that a disproportion between the resistance of the cornea and the intra-ocular pressure constitutes the proximate cause of keratoconus. In our case there was first kerato-iritis, by which the texture and resistance of the cornea were changed; secondly, a secondary increase of pressure supervened; and thirdly, an injury was superadded, which again may have diminished the resistance of the cornea.

Von Graefe taught that certain conditions in the natural thickness of the cornea constituted a predisposition for keratoconus, the actual formation of which was due to the supervention of slight alterations.* It is well known that the thickness of the cornea varies in different persons within rather extensive limits. Krause† records, *e.g.*, the thick-

* Arch. f. Ophth. iv. 2, 272.

† Meckel's Arch. f. Anat. u. Phys. 1832, page 113; and Poggendorf's Annalen, Bd. 39, page 531.

ness of ten corneæ in Paris lines; Jäger, jun.* groups together twelve cases, the measurements of which are expressed in millimetres. The extremes observed were as follows:—

Krause.—Thickness of the thickest cornea:	*a* in the centre	0.53‴
" " "	*b* at the margin	0.63‴
" thinnest "	*a* in the centre	0.022‴
" " "	*b* at the margin	0.5‴
Jäger.—Thickness of the thickest cornea:	*a* in the centre	1.2 mm.
" " "	*b* at the margin	1.4 mm.
" thinnest "	*a* in the centre	0.7 mm.
" " "	*b* at the margin	1.1 mm.

These comparatively few measurements show a considerable range of physiological variations of the thickness of the cornea. If we suppose, according to Helmholtz, that in consequence of an increase of pressure a perfectly normal cornea never assumes a conical form, but on the contrary becomes flattened, we must, on the other hand, grant that, by an increase of intraocular pressure, an extremely thin cornea may become distended whenever its nutrition be but slightly disturbed and its power of resistance lessened. In order that a conical projection of the cornea be produced, a rather inconsiderable disturbance of nutrition, extending equally over all parts of the cornea, seems essential. From this pathological projection we can readily derive the natural conditions of corneal thickness. The cornea is always thinnest in the centre and constantly increases in thickness towards the periphery.

According to Krause, the thickness of the cornea amounts to :—

a in the centre 0.022‴—0.5‴
b at the margin 0.05‴ —0.7‴

According to Treviran: *a* in the centre 0.3‴—0.54‴
b at the margin 0.5‴—0.71‴

According to Jäger: *a* in the centre 0.7 mm.—1.2 mm.
b at the margin 1.1 mm.—1.4 mm.

A proof of the abnormal thinness of a conical cornea is furthermore

* Ueber die Einstellungen des dioptrischen Apparates im menschlichen Auge. 1861. 276 and 277.

found in the fact that it is very difficult to excise a portion of the apex of the cone without opening the anterior chamber.

The two cases of paralysis of the recti muscles (23 and 48) yielded a negative result; in 48, the normal eye had the very same degree of tension as the eye the recti muscles of which were paralyzed; in case 23 the tonometrical record of the sound eye was lost.

We could reach no definite conclusions as to the conditions of tension in cases of simple cataract. In the majority of cases the tension was normal; in some cases we noticed a slight increase. Even in diabetic cataract we found no diminution of tension.

Case 88, sarcoma chorioideæ, shows a moderate increase of tension, 28.5° To. The tumor, of globular shape and brownish color, extended over the greater part of the inner half of the globe. The outer portion of the fundus appeared normal; in the corresponding portion of the visual field the patient read ordinary newspaper print. The microscope revealed spindle-shaped cells containing brown pigment.

Glaucoma, tonometrically considered, the most important affection, furnishes the greatest contingent to Table X. The tension of the recorded cases varies between 26 and 26.5° To. and between 60 and 200 mm. Hg. In Dor's cases the tension varies from 30 to 46° To. = 55 and 250 mm. Hg. We perceive that tonometrical degrees can be readily commuted into Hg. mm. Dor's previous measurements are therefore comparable to the results of his recent examinations. I am convinced that

in cases of glaucoma the tonometer is of great practical importance, and at times furnishes an indication for iridectomy. In support of this statement I cite case 79. The patient presented himself at Moorfield's Hospital in the following condition. Central vision $\frac{1}{25}$; nasal half of visual field considerably contracted, optic disc atrophic and pathologically excavated. Vitreous body clear. Patient had never noticed rainbow colors; suffered no pain. He stated that during the last years his sight had been more or less cloudy. After palpation the tension was declared normal, and the patient advised to return in case his sight should become worse. No diagnosis was made. I then was allowed to examine the eye tonometrically, and found a tension of a little over 28° To.; the sound eye had a tension of 26.5°. It was evident that there existed a slight increase of intraocular pressure which had not been recognized by palpation.

In their experiments Hippel and Grünhagen found very important facts, which seem to demonstrate that in simple glaucoma the increase of tension is attributable to an abnormal irritation of the secretory nerves along the course of the trigemini, and that the rigidity of the sclera and the sclerosis of the arteries merely constitute predisposing causes. This view is also borne out by the following observation. At the clinic in Utrecht, Snellen succeeded in diminishing the increased intraocular pressure by subcutaneous injections of morphine, especially in those cases in which the eyeball had again attained a pathologically high degree of tension after iridectomy.

Unfortunately, I was unable at that time to examine tonometrically the degree of diminution of tension caused by the morphine. It can hardly be doubted that this effect of morphine is produced through the agency of the fifth pair, since it has been demonstrated experimentally that irritation of the trigemini increases the intraocular pressure by dilating the blood-vessels of the iris and choroid, and by impeding osmotic action. Irritation of the sympathetic nerve diminishes the intraocular pressure. We may also here mention that temperature and weather seem to exert an influence upon the occurrence of glaucoma. It has been noticed by various observers that severely and unintermittingly cold weather has a certain connection with the more frequent occurrence of glaucoma. Last winter we had an opportunity of corroborating this statement at Moorfield's Hospital. During the months of January, February, and March the number of glaucoma patients was excessively great, and Drs. Hulke and Cooper ascribed this circumstance to the excessively cold weather which had prevailed in December and January.

In conclusion, we may consider the following questions: "What are the views held at the present day on tonometry in general?" and "To what extent has the tonometer been adopted in ophthalmological practice?"

Many ophthalmologists regard the method of palpation as satisfactory for practical purposes; others feel the want of a tonometer, but are dissatisfied with the instruments hitherto constructed. What may be accom-

plished with Monnik's new instrument, the future will teach us. I have made but little use of it experimentally, and, therefore, reserve my judgment as to its practical value; theoretically it represents a decided progress in tonometry. Monnik's tonometer possesses, however, the material disadvantage of causing a considerable outlay, its price being twice as high as Dor's.

Dor's instrument, though incontestably the best of the older tonometers, has practically been tested by only a limited number of ophthalmologists. It is a very common belief that palpation yields as accurate results as tonometry. Palpation, therefore, to this day remains the general method, and tension is expressed according to Bowman's suggestion by the signs Tn, T_1, T_2, T_3,—T_1,—T_2,—T_3. In this paper I believe to have clearly demonstrated that the accuracy of Dor's tonometer cannot be obtained by palpation. The subjective results of palpation are strikingly illustrated by an instance at Moorfield's Hospital. Two eminent specialists estimated the tension differently, the one considering it slightly increased, the other, slightly decreased. There was a discrepancy of two degrees, T_1, and — T_1.

The principal reason why Dor's tonometer failed to be extensively introduced into practice seems to be that its management is somewhat difficult, and its method of measurement somewhat complicated. I am convinced that but few observers understood and employed the instrument correctly. In support of this statement, I

refer merely to the measurements* made at Zürich. Two errors were committed. First. The curvature was noted 10 mm. too high; instead of 28–30, as representing the curvature of normal eyes, 18–20 ought to have been found. The graduation of the arc commences with 10; this signifies that 10 gr. will only balance, but not move, the loosened spring. Eleven gr. will move it to the next subdivisional line. In the measurement of curvature the starting-point 10 is in reality zero, and therefore 10 ought to have been subtracted from the resulting values. Secondly. Instead of subtracting the curvature from 2 mm. before the measurement of tension, the curvature was measured first and then subtracted from the value of tension.

Mr. Emin,† who peremptorily condemns Dor's tonometer, evidently knows very little about it.

Stellwag von Carion does not seem to attach much value to tonometry. In the beginning of his paper "On intra-ocular pressure, and the conditions of innervation of the iris," he says: Ophthalmotonometers which serve to measure the resistance of the eye-ball against an outer force, are by no means the proper instruments for the determination of intra-ocular pressure. They may, however, be employed to obtain the difference of tension between the eyes of the same person if we assume the

* Ueber Hydrophthalmus congenitus. Inaugural-Dissertation von Wilhelm v. Muralt. Zürich, 1869, p. 39.

† Etude sur les affections glaucomateuses de l'œil par Mahomed Emin. Paris, 1870.

same degree of elasticity for both scleræ. Stellwag is perfectly right in supposing that the sensible hardness partly depends upon the rigidity of the sclera, and cannot be considered the exponent of intra-ocular pressure. In tonometry it would certainly be more correct to substitute the terms, "degrees of tension," or better still, "degrees of resistance," for "values of pressure;" but we can easily come to an agreement regarding the significance of the latter term. It seems hardly intelligible that we shall ever be able to estimate more correctly the intra-ocular pressure in the living man by any other method than that of measuring the resistance of the eyeball against a constant outer force. In palpation, as well as in tonometry, we have to cope with the rigidity of the capsule. In the course of the above-mentioned paper, Stellwag speaks more favorably of the tonometer. He holds that tonometrical measurements solely may demonstrate the direct in-influence of mydriatics and myotics upon the degree of tra-ocular pressure, and says, furthermore: "We cannot exclude the possibility that the consistence of the eyeball may exhibit such minute variations as are only demonstrable with very sensitive instruments." Stellwag demands a tonometrical proof of the alleged effect of atropine to diminish the intra-ocular pressure. This proof may be found in the third section of this paper.

NOTES ON OPHTHALMOLOGICAL AND OTOLOGICAL SUBJECTS, MADE DURING A JOURNEY THROUGH EUROPE.

By H. KNAPP.

Toward the end of May, 1871, I left New York for Europe, in order to inform myself, by personal inspection, of the progress eye and ear surgery had made in the most cultivated of the continents during the last three years. I travelled five months, looking about for instruction and listening to information with as much attention as I could command. The profit derived from travelling is, of course, mainly personal, and the incentives we receive to renewed exertion are, I think, more valuable than the instruction we carry home. If we could at once convert into lasting intellectual property all we see and hear, the benefit of scientific travel could not be too highly estimated; but the more rapidly the new impressions follow one another the less they are realized, and the sooner they escape our memory. How little do the most attentive retain from a scientific meeting in which papers and discussions on varied subjects occupy their minds for a few days only. They carry home a vivid general impression of the meeting, are encouraged

and satisfied, but after some weeks they recollect no more than a limited number of objects the outlines of which had been unusually sharp and prominent. If the reports of the meeting, or, better still, the original papers when printed, do not come to their aid, only a small part of what they have seen and heard will be converted into available mental property. The same consideration holds good with the observations made during a journey. We master but little when we are on the wing. He who travels without taking notes overrates his powers of comprehension and memory, and does not know to profit by one of the greatest opportunities of improvement. Such notes are a treasure of large dimensions but uncouth exterior, which we have subsequently to work up in order to add it to our store of knowledge, available whenever occasion demands.

Every one takes notes according to his own requirements and abilities. They are doubtless useful to him; but is it worth while to publish them? I think it may be. Some, and often the best, practitioners write but little. It must be agreeable to them, if another endeavors to enrich science by giving the results of their experience to the world. Others preserve to themselves alone the right to publish their researches, justly considering it an indiscretion on the part of any one who anticipates them. I shall not, wittingly, communicate anything in this report which is likely to displease the gentleman from whom I learned it. Subjects of great practical interest, especially such as concern therapeutics

and operations, will be frequently mentioned, though they have already been published by their authors. This I consider of great value; for it shows whether the opinions entertained by the authors, and the recommended methods of investigation and treatment, have stood the test of time. Sometimes a mode of examination or treatment is brought before the public with all the warmth of conviction, and when we come to visit the author, some years later, we see his apparatus laid on the shelf, and the method abandoned, no revocation or correction having ever appeared in literature.

A reporter should be a mirror reflecting an image of the practice of different people and institutions. The value of such an image necessarily depends upon the quality of the mirror. An opaque and astigmatic mirror will produce a dull and distorted image. I am well aware that my notes suffer from these imperfections, occasioned, in part, by the unavoidable haste with which they were collected. I feel, however, comforted in the thought that ophthalmologists know how to diagnosticate and correct the opacities and anomalies of curvature of a mirror, and otologists are able to recognize whether certain reported dissonances are the effect of false tuning of the Corti's organ of the listener, or real imperfections in the piece of music. Whenever I have described an object unsatisfactorily or wrongly, I beg the favor of being set right in this or some other periodical.

I shall abstain alike from laudation and censure, the former being out of place in a scientific journal, the latter

savoring of ingratitude, considering the kind reception I met with everywhere. The thoughtful reader will peruse this report, as he does everything, with critical eyes, and may, without loss, miss my personal views.

I. Notes on Ophthalmology.

W. Bowman, in London, as he described some years ago, cuts the iris, in performing *iridectomy*, in two strokes with a pair of scissors, the straight branches of which are bent at a very obtuse angle on the edge of the instrument. Having seized the iris in the middle of the section, drawn it out and somewhat on the stretch, he first cuts it within one corner, then tears it off its ciliary attachment along the whole section, and cuts the last part of it within the other corner of the wound. The method yields a broad peripheric coloboma, the shape of a keyhole.

In cases of almost *total adherent leucoma*, where there is only a narrow stripe of transparent cornea left, *Bowman* makes an artificial pupil in a peculiar way. Instead of entering at the corneal margin, where the cornea is clearest, and advancing the point of the knife meridionally, *i. e.*, toward the centre of the anterior chamber, he introduces the knife through the cornea at some distance from the place where the artificial pupil is to be situated, in such a way that the *blade* of the knife is turned not circularly, as usual, but meridionally. The point of the knife is then pushed through the remnant of the anterior

chamber, in the direction of a chord lying under the clearest piece of cornea. The remainder of the operation is executed according to the conditions of the case. Bowman intends by this method to obviate the occurrence of any further opacity in the only available part of the cornea.

Bader, of Guy's Hospital, presented in his clinique a case of alleged congenital irideremia, in which chronic internal inflammation of a glaucomatous nature had subsequently developed in both eyes. No iris being present, iridectomy had to be replaced by division of the ciliary ligament. This operation had been performed in both eyes some months previously. The one still showed an increase of tension and general enlargement; the other, —T_1 and a depressed scar in the place in which the sclerotic had been pierced. The scar extended from the transparent corneal margin back about 3‴. The case seemed almost hopeless, sight being very poor. Dr. Bader said, however, that sight had improved in the second eye; but the indrawn scar in the ciliary region and the diminution of tension, indicating a phthisical condition of the globe, were proofs that the operation could not, in any event, have benefited the eye for any length of time. An indrawn scar in the ciliary region is a dangerous lesion, being very liable to produce sympathetic irritation in the fellow-eye. Its presence after Hancock's operation for glaucoma is a serious objection to that method, even if general experience had shown that it yielded a greater rate of success than I have seen from it. Its performance is certainly excusable in cases of absence of the iris, but

Bader's observation does not even then argue in its favor.

Liebreich's new iris forceps have become a very neat and useful instrument by the essential changes M. Mathieu, in Paris, has made in them. The former broad and clumsy branches, opening like a book, are replaced by the ordinary branches, which, being probe-like near their ends, are enclosed in a small tube. When they are pressed upon in the ordinary way the ends close, and when the pressure ceases the instruments open in such a manner that the ends of the branches diverge from their point of exit out of the tube, which lies about 3''' from their toothed end-points. The instrument has some evident advantages: 1. It can be introduced through the smallest corneal wound, and, on account of the ends diverging within the eye, grasp nevertheless a large portion of iris, or other substances; 2. The teeth of the instrument being on the posterior edge, and not on the end of the branches, facilitates the seizure of loosely supported or floating bodies, such as irides in aphakial eyes. Unyielding membranes also, especially irides totally united to the crystalloid, may be more firmly grasped with this instrument. I saw it repeatedly and successfully employed in London. Dr. Bader, for instance, removed with it the whole iris in two cases of chronic iritis with consecutive glaucoma. I will not say that in most cases the objects aimed at might not as well have been attained by the ordinary forceps, but I dare say that the instrument in its present shape is of very ingenious device, and appears

convenient. Since my return to New York I have myself used it several times, and was well pleased with it. It is, however, pretty expensive, and, on account of the tube, somewhat difficult to be kept clean.

Liebreich himself, to whom the managers of St. Thomas' Hospital have given, with unprecedented liberality towards a foreigner, the direction of the ophthalmological department in the hospital, and a professorship in the medical faculty of the college, I found engaged in making arrangements for his clinique. I was greatly pleased with the abundance of space that had been allotted to it—namely, seven rooms for out-patients, besides twenty-five beds for in-patients. The rooms were selected and fitted out exactly as Liebreich desired and indicated. He showed, in his arrangements, a good deal of practical sense, and great talent of organization. There was a proper entrance and exit; two waiting-rooms, one for women and children, the other for men; a reception-room, where they were treated; a dark room with four or six ophthalmoscope lamps, and blackboards near each on which to sketch, for the students, the appearances of the fundus oculi; besides an operating-room, a druggist's room, and a small private sitting-room. This newest ophthalmic institution in the metropolis is worthy of the magnificent hospital of which it forms a part, certainly not the least useful and important one.

Moorfield's, or the *Royal Lond. Ophth. Hospital*, has lately been considerably improved and enlarged. It treats a greater number of eye-patients than any other insti-

tution in the world. It has about one hundred beds, and its accommodations for the out-patients' department, the library, anatomical collection, etc., are adequate to the extraordinary demands on this charity. There are, annually, about 20,000 patients treated, and 1,600 operations performed in this hospital. In the number of operations, however, are included such trifling performances as slitting the lachrymal canaliculi, opening small palpebral abscesses, removal of foreign bodies from the cornea, etc., which many other institutions do not count.

In Moorfield's and many hospitals of Great Britain I saw cataract extraction performed according to Graefe's method: upper section, mostly in such a way, however, that only the ends of the section lay in the scleral border, while about three-fourths of its external margin were in the transparent cornea. I noticed with some surprise that *Bowman*, whom I had seen, three years previously, place the entire section—I always mean its outer visible margin—within the non-transparent corneo-scleral junction, now places the centre of it a little within the transparent border. *Mr. Critchett*, on the other hand, who at that time used to cut deeply into the transparent cornea, now makes a peripheral section throughout with a considerable elevation of the flap. *Mr. Bader* made a lower section lying, with the exception of its extremities, wholly in the cornea. He made a small iridectomy, expelled the lens by pressing with the upper lid upon the cornea, and endeavored, not altogether successfully, to remove the remnants of corticalis by rubbing. The section

had been performed by sawing movements. On examining the narrow knife I found that its surfaces were convex —a condition which renders it difficult for the instrument-maker to grind the edge very sharp. *Bader* operates frequently—and did so, before A. Weber described his method—with a broad lance-shaped knife, the surfaces of which are flat as usual, while the base is prolonged into a short piece with cutting edges parallel to each other, in order to make the inner margin of the section as wide as the outer. The knife cuts well, and the operations I saw him perform in this way were mostly smooth; in some of them the section seemed to be too small, for he dilated it with the instrument of Dr. Charles Bell Taylor (of Nottingham), which is a broad needle bent on the flat at an obtuse angle.

On several occasions I saw, in London, the *suction* method employed. At Moorfield's it was done for ordinary soft cataract in young persons. The section was made with a lance-shaped knife, the capsule freely lacerated with a needle—which in London is used for this purpose in preference to the pricker or kystitome—and the soft lens-matter sucked out with Bowman's instrument. *Bader* employed suction successfully in a case of cataracta accreta mollis. He performed iridectomy, and extracted the false membrane on the anterior capsule with Liebreich's forceps, and then sucked the soft parts of the lens out by means of an instrument of his own device, which appears simpler than Bowman's. The small silver end-piece, which is introduced into the anterior

chamber, is stuck into an India-rubber tube, at whose other end is a glass tube which the operator takes into his mouth, and produces the suction by his own inspiration.

At Moorfield's a *modification of Liebreich's squint operation* has been introduced. They raise the conjunctiva at the lower edge of the tendon, incise it horizontally, divide with straight scissors the cellular tissue between the conjunctiva and the outer surface of the tendon and muscle, grasp the tendon upon a hook which is longer and less bent than the ordinary squint-hook, and sever the tendon subconjunctivally. This done, they raise the conjunctiva with the hook, and cut through the loose tissue between the sclerotic and the elevated conjunctiva, in order to divide any fibres which by chance may have escaped. The scissors, during these last strokes, are held with their edges perpendicular to the sclerotic, and these last strokes are made in the region of the insertion of the tendon into the sclerotic. There is a great deal of cutting done in this operation, which does not, on the whole, make a favorable impression upon the spectator.

Bowman performed an enucleation with the utmost neatness in the following way:—The lids were kept apart by the ordinary racket wire speculum. The conjunctiva was severed around the whole cornea, close to its margin. The four recti were divided as in strabismus operation. The eyeball was drawn a little forward with the same fixing forceps, and the optic nerve cut with the same scissors which had been used for dividing

the conjunctiva and tendons. The eye-ball was drawn out of its socket, and the tendons of the oblique muscles were divided. The eye was thus removed in the cleanest possible manner. A thread was passed in four places through the conjunctiva with a curved needle having its eye near the point, such as is used in staphyloraphy. The wound was closed by drawing at the two ends of the thread, which are kept united by simple twisting. The bleeding was stopped by pressing a small wet sponge upon the closed eyelids.

Dr. Bader told me that he had employed successfully in eight cases *a new operation* for *conical cornea.* He first passes a delicate curved needle, threaded with thin silk, from above downward as far as about its middle part through the base of the conically projecting portion of the cornea, where it is left in. Next he divides the lower half of the cone with a Beer's knife, then the upper half with scissors. He now draws the needle wholly through the cornea and unites the wound by tying the silk thread. There was no suppuration in any of these operations. *Bowman* told me that he had successfully operated on one case according to Bader's method.

In some of the hospitals (Moorfield's, Guy's) I saw *Bichloride of Methylene* used for anæsthetizing purposes. They employed a funnel-shaped apparatus with an opening of about ¾″ in diameter at the small end. About twenty drops of the liquid were poured upon the inner walls of the apparatus, which were lined with cloth. Its broad margin was so placed upon the face that it enclosed

completely the patient's mouth and nose. The opening at the narrow end of the instrument was closed with the hand as long as is required to count 40. If the patient then is not yet anæsthetized, chloroform or a new supply of methylene is to be given until the narcosis is complete. The patients looked cyanotic, and I was somewhat afraid on account of their asphyctic appearance. The advantage of this mode of producing anæsthesia is the rapidity with which it is obtained, thus saving the surgeon a great deal of time.

Throughout my whole journey I saw chloroform used for anæsthetic purposes, in London sometimes bichloride of methylene, but nowhere ether. There are already some cases of death from bichloride of methylene on record. The opinion seems to prevail that for equal degrees of anæsthesia, the different anæsthetics involve the same danger. If ether, the weakest anæsthetic, boasts of the smallest number of accidents, it is because in the majority of cases it is not given in such quantities as to produce complete anæsthesia. This is certainly a great drawback in many operations, the delicate execution of which requires immobility of the patient. If, apart from this, the greater length of time required by ether is taken into account, we must not be astonished that preference is given to chloroform. In Germany the method of giving chloroform used in Langenbeck's clinique has become very wide-spread. Chloroform is sprinkled on the knit woollen cover of an oblong wire case, the free opening of which is placed over the mouth and nose of

the patient. Two of the wires are prolonged to form a convenient handle for the little instrument.

Concerning the preservation of specimens of the eye, I may here still mention that at Moorfield's Hospital the anatomical specimens are very perfectly put up in a fluid which, according to the curator of the Hospital, Dr. E. Nettleship, consists of glycerine and lamb's-foot jelly. The latter is to be taken as white as it can be had.

W. Wilde has a large and very instructive collection of drawings of external ophthalmic diseases, from cases observed in St. Mark's Ophthalmic Hospital, a charity which he founded. These drawings are very beautifully executed in colors, and represent a great many important conditions, which have attracted less notice than they deserve by the surgeons of the ophthalmoscopic era.

Dr. *Wilson*, Surgeon to St. Mark's Hospital, Dublin, showed me some cases where, for inverted lashes, he had pared the free edge of the upper lid. They looked very satisfactory, but a patient whom I saw elsewhere, operated on by him in the same way, suffered from a sclerotic condition of the cornea, and said the movements of the lids irritated the eye, and the operation had given him no relief. It is impossible to judge of the value of an operative method from seeing cursorily a few cases on which it has been practised. The profession generally, I think, have abandoned the above-mentioned procedure.

Dr. *Swanzy*, Surgeon to Adelaide Hospital, Dublin, showed me a case of peculiar interest, on account of the

combination of iritis serosa and keratitis parenchymatosa with the symptoms of Ménière's ear disease. The case was that of a lady lately returned from India. Although no history of syphilis was traceable, both the diseases healed under anti-syphilitic treatment. As the attention of the profession has only lately been called to the combination of eye and ear diseases of an exudative (serous) character, I trust Dr. Swanzy will give us a fuller record of his observation.

In *Glasgow* I was astonished at the fearful number of injuries of the eye presenting themselves at the hospitals. The flourishing iron industry, and the extraordinary extent to which ship-building is carried on in this large city, explain this fact sufficiently. The surgeons seemed to favor, more or less, the principle of non-interference, especially in not being too hasty in taking injured eyes out, lest the fellow-eye become sympathetically inflamed.

Dr. *T. Reid*, Surgeon to the Glasgow Eye Infirmary, the principal field of Mackenzie's work, operates for cataract mostly according to Von Gräfe's method, but he still performs sometimes the old flap section with a Beer's knife.

Dr. *T. R. Wolfe*, formerly of Aberdeen, has opened a new Ophthalmic Institution. He now makes his cataract operations with a narrow-bladed knife, large flap-like sections, and *simultaneous* iridectomies.

Dr. *Walker*, in Edinburgh, operates likewise according to Von Gräfe's method, laying, however, the centre

of the section within the transparent cornea. He is afraid of instilling atropine immediately, and even some days after the operation, on account of its irritative quality. Many surgeons hold the same opinion, I believe, without sufficient ground. I have always been in the habit of dropping atropine into the eye immediately after operations for cataract and artificial pupil, and am not conscious that any disturbances in the healing process were due to the irritant action of this remedy.

Dr. *Argyll Robertson*, of Edinburgh, presented a case of *spinal myosis* to which he has the merit of having recently called the attention of the profession. In spinal myosis he observed that the pupil does not respond to changes of light, but to accommodative efforts. When the patient looks at a remote object, his narrow pupils dilate somewhat, and when he looks at a near object, they contract. The case presented by Dr. A. Robertson fully confirmed this statement. It was a man of about 48, with evident symptoms of spinal disease, white optic discs, $V = \frac{20}{40}$. I have since had several opportunities to verify Dr. Robertson's observation.

I did not neglect to visit repeatedly Prof. *Lister's* surgical wards and to see him operate. His well-known mode of antiseptic treatment is practised there even more thoroughly than would appear from his previous publications. In every part of the body in which respiration, digestion, etc., do not produce a passage of air, he operates in a so-called "*antiseptic atmosphere*,"

i.e., two assistants are constantly throwing a spray of a weak solution of carbolic acid over the region of the operation and upon the wound. The same is done when the dressing is changed, so that neither during the operation nor during the after-treatment is a wound or ulcer exposed to the natural air. The dressing is done most carefully. I was astonished at the clean and healthy appearance of all the wounds and at the small quantities of pus they secreted. Most of them did not show any discharge at all. I found Prof. Lister a most amiable man, ready to communicate his ideas and demonstrate his methods to strangers, though to repeat this so often cannot be very entertaining for him. He has employed his mode of treatment successfully in plastic and other operations of the eyelids. In purulent ear diseases its efficacy is frustrated by the communication of the middle ear with the air through the Eustachian tube.

In *Utrecht*, Prof. Donders showed me, with his habitual kindness, some new apparatus in his physiological laboratory. By one I could readily convince myself of the existence of a limited compensatory wheel-rotation of the eyes, both for near and distant vision, in lateral inclinations of the head. Another most ingenious apparatus served to test the judgment of the locality of visual objects exclusively from the impression they make upon one or both retinæ. The wires from an electric battery are led into a completely dark room, in which are the experimenter and another person. The electric

spark illuminates the room for an instant only. The person desired to point out with the finger the place where the spark appears to him scarcely ever fails to touch the electrodes if he has both eyes open at the time of the flash, but frequently fails to point out the right place if only one eye is open. The influence of the muscles on the localization of visual objects is excluded in this experiment, because the illumination is only momentary.

Dr. *Snellen* performed some *cataract* extractions according to Von Gräfe's method. The section was completely within the scleral border, and approached greatly to a flap. He unites the edges of the wound by a delicate suture in case they are not spontaneously in close co-aptation.

In *strabismus* operations he incises the conjunctiva horizontally, and corresponding to the middle of the tendon, loosens the conjunctiva from the muscle, divides the tendon from the sclerotic, and enlarges the line of division upward and downward. Finally he unites the conjunctival wound with a suture. He says that this mode of operation produces large effects.

He operates for *ectropium* with a thread, armed with two needles which pierce the conjunctiva not far from the swelled and everted edge of the lid, at a distance from each other of about 6 mm., and come out on the skin of the lid at the same distance from each other, but of 6 to 8 mm. below the eyelashes. A small piece of paper is placed on the skin between the ends of the

thread, which are tied over the paper so firmly as to produce a slight entropium. The paper serves to protect the skin from being cut by the thread. The suture is removed the next day, or later, according to the degree of inversion which has been the immediate result. The effect of two such operations I witnessed was admirable. After the removal of the sutures some inversion existed, and there was no tendency to eversion from the movements of the lids.

The Eye Hospital in Düsseldorf I found comparatively empty, in consequence of an epidemic of variola which shortly before had been in the neighborhood. Dr. *Mooren* had just begun to take patients in again. He performs cataract operation after Von Graefe.

Prof. *Saemisch*, in Bonn, expressed himself as being well satisfied with the results of his treatment of the "*ulcus corneæ serpens.*" This treatment consists, as is known, in cutting through the whole depth of the cornea in the midst of the abscess with Graefe's cataract-knife. The aqueous humor escapes. The wound is reopened and the anterior chamber emptied one to three times daily, until the edges and the ground of the ulcer have become perfectly clean and healthy-looking, which sometimes does not take place till after some weeks. I have tried this plan of treatment in some cases, according to the rules laid down in Saemisch's monograph, but, I am sorry to say, have not been so successful as its originator. The opinions of other ophthalmic surgeons whom I consulted on this subject, were so divided that I am anxious

to see a further account of Prof. Saemisch's late experience in his bold plan of treating so dangerous a disease as the wandering corneal ulcer.

In Darmstadt I had an opportunity to see Dr. *A. Weber* perform an extraction of cataract according to his own method. The operation was not without accidents. The point of the curved, lance-shaped knife passed behind the lower part of the iris. The expulsion of the lens was tardy—vitreous escaped before the exit of the cataract—and cortical matter had to be left in the eye. The case, nevertheless, did well, as Dr. Weber told me two months later. He stated that accidents were very rare during the operation; that he had tested the method now on a large scale, and was highly satisfied with the results.

Dr. *Alexander Pagenstecher*, in Wiesbaden, performed in my presence an extraction of cataract, together with the capsule. He made the incision in the sclerotic with Graefe's knife, and then a broad iridectomy. He held the globe with a fixing forceps himself, introduced a large spoon behind the lens, while an assistant pressed gently upon the cornea with a hard-rubber spoon, passing it from below upward as the lens moved toward the section and out of it. The cataract, thus held between the edge of the spoon and the depressed cornea, cannot escape, but must needs be forced out through the wound. In the present case, however, the capsule, which was thickened in its centre, burst near the equator, and remained in the eye, while the lens was removed, not without some escape of vitreous. Pagenstecher was not

pleased with this operation. He said that the bursting of the capsule, which could not always be prevented, was the only drawback to this method of operating, the mode of healing and the results of which were excellent whenever the removal of the lens, together with the capsule, was successful. He performs this operation promiscuously with Graefe's method.

Pagenstecher *obliterates the lachrymal sac* in the following way :—First, he slits the canaliculi and the inner wall of the sac near the caruncle ; then he places a dossil of lint into the opening to prepare it for the introduction of the caustic,—a paste of one part of chloride of zinc to two or three parts of amylon.

At Göttingen I saw, in Prof. *Baum's* surgical wards, a very remarkable case of *lesion of the spine.* A boy had been stabbed into the nape of the neck, on the right side. He showed marked symptoms of a lesion of the right side of the spinal marrow. When I saw him the right pupil was under the influence of atropine, but only very little dilated. Prof. *Leber* stated that, prior to the instillation, it had been narrow and immovable. This being a case of one-sided traumatic *spinal myosis*, I begged Prof. Leber to test, when the effect of the atropine had subsided, the mobility of the pupil, both on changes of light and on changes of accommodation or convergence. He informed me later that the disease had healed so quickly and completely that examinations of the pupil had not yielded a definite result.

Prof. *Leber* has a fine collection of anatomical, espe-

cially microscopic, preparations, which he kindly showed me. Most of them form the basis of several papers he has published in Graefe's Archives. A separate Ophthalmic Hospital was being built in Göttingen, forming an addition to the institutions of the old and celebrated University of this city, where the anatomy and physiology of the eye and ear are taught in a classic manner by the renowned Professors *Henle* and *Meissner*.

At *Halle*, Prof. *Alfred Graefe* had the kindness to show me his Ophthalmic Institution. There wree a great number of inmates, many of whom were operated on for cataract. Alfr. Graefe performs extraction according to the plan of his late cousin, but with a downward section. All the operated patients I saw were in a fair way of recovery.

At *Leipsic* I visited several of the new institutions belonging to the University. There is no place of learning in all Germany where science is more liberally encouraged than in Leipsic. The institutions for medical instruction in particular are nearly all new and on a grand scale. The Physiological Laboratory of Prof. *C. Ludwig* is very extended, and adapted to every kind of physiological research. A steam-engine, heated by gas, does the mechanical work, and contributes greatly to the regular performance and success of many experiments; for instance, it moves the registering apparatus, keeps up for hours artificial respiration in animals poisoned with curare, etc. This laboratory, indeed, is an international

workshop, in which I found Germans, Americans, Russians, Italians, and Swedes.

Instigated by the above-mentioned important statement of Dr. Argyll Robertson, and that remarkable case I saw in Prof. Baum's wards, I made some experiments on the *conditions of the pupil in lesions of the spine.* In these experiments I was kindly guided by my former teacher, Prof. Ludwig, who was exceedingly amiable, as, in fact, he always is. I first divided the sympathetic nerve on the neck of a rabbit. The pupil of the same side became contracted, but remained movable on changes of light. After that, I cut one-half of the spinal marrow, between the fifth and sixth cervical vertebræ of another rabbit: this animal showed paralysis, increased reflex irritability of the muscles of the same side of the body. The pupil of the same side was narrow, but distinctly responsive to light. I then divided also the other half of the spinal marrow at the same places, and found complete paralysis, with increased reflex irritability of the muscles on both sides. Both pupils were narrow, but movable on changes of illumination. The subsequent division of the sympathetic nerves at the neck did not alter the state of the pupils. These experiments only confirm the well-known fact that the dilatation of the pupil is effected by the sympathetic nerve, the fibres of which pass through the lower part of the cervical spinal marrow. Concerning A. Robertson's observations on spinal myosis they prove *that the centre of the reflex mobility of the pupil on changes of light is situated above the fifth cer-*

vical vertebra. Though these experiments have to be continued, even this primary result seems to be not without some importance in the diagnosis of spinal affections.

In the clinic of Prof. *Coccius* I saw many new procedures. He *tests intra-ocular pressure* by first dipping his two fore-fingers in warm water, and then placing them on the sclerotic, below the cornea. By pressing in the manner as in ascertaining the existence of fluctuation, the thickness of the ocular wall and the tension of the globe can, according to Coccius, be more accurately determined than by the usual palpation through the lids.

Secondary and shrunken cataracts, Prof. Coccius operates by entering with a needle into the external part of the limbus conjunctivæ, and depressing them into the vitreous with the flat suface of the needle. On inquiry, Coccius stated that only little reaction, if any, followed this operation. The case I saw him operate on in this way showed none whatever.

Coccius frequently employs *catheterism* of the *nasal duct* from below. The nose must first be cleansed by syringing with warm water, in order that no scabs plug the orifice of the lachrymal duct. He then introduces a curved, well-greased catheter, a modification of Gensoul's instrument. To inject lotions in this way is certainly rational, as diseases of the tear-passages more frequently originate in affections of the nasal than of the ocular mucous membranes.

Coccius made a *regular flap section* with Graefe's knife, then iridectomy, and laceration of the capsule in the usual way. During the removal of the lens he raises the flap with a hard-rubber spoon, and presses gently on the globe with the fixing forceps. In case vitreous escapes, he extracts the lens with a double hook, such as was formerly used to fix the globe in strabismus operations.

There is a large collection—the largest I have seen—of *ophthalmic instruments* at the Leipsic Ophthalmic Institution. It is of great historic value. The name of the inventor of each instrument is written on a label attached to it. Many an instrument of modern device has its like in this collection. The lance-shaped knives, for instance, either flat or curved on the surface, as Bader and A. Weber now use, are to be found in the Leipsic collection, as invented by Santorelli.

Prof. *Schweigger*, in Berlin, practises *tatooing*, according to *Wecker*, in order to remove the disfigurement from leucomatous eyes. He was pleased with the results of this procedure.

He showed the case of a girl, twelve years of age, in whom he had performed discision for *zonular cataract* without iridectomy. The lenses were absorbing, and no symptoms of irritation had thus far been present.

Dr. *Ewers* performed some *extractions of cataract*, strictly according to Von Graefe's plan. Dr. *Hirschberg* and some other ophthalmic surgeons of Berlin operate in the same way.

Dr. *Ewers* performed partial peritomy in a case of partial trachomatous pannus. In *Langenbeck's* Surgical Clinique and Hospital I saw some highly instructive cases and operations. In a woman of about 40, the tip and lower right half of whose nose had been destroyed by epithelial cancer, he removed the diseased parts and the adjoining tissue freely, and stopped the bleeding with a spray apparatus. He replaced the defect by a flap taken from the right side and back of the nose immediately above the denuded part. The base of the flap was in the right cheek, and its broad opposite end on the other side of the nose. After its detachment it was very pale and considerably shrunken. Langenbeck said "this was of frequent occurrence, and due to the contraction of the smooth muscles in the flap. The surgeon need not be afraid either of the pallor or of the apparently insufficient size of the flap." The flap was shifted down over the defect, its end united with the corresponding edge of the wound by some silk sutures, and the denuded surface covered with "*charpie râpée*," which remains undisturbed until suppuration underneath has taken place, ordinarily between the fifth and sixth days. Up to that time the flap is entirely immovable, a condition which greatly favors its union with the adjoining parts. Langenbeck thinks that the "*charpie râpée*" is an almost indispensable means of dressing in such operations. I have seen Dr. *Gurdon Buck*, of New York, for the same purpose employ picked lint, the successive layers of which were painted with collodium until the denuded

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part was filled up with a thick hermetic layer, rendering the flap immovable This layer of lint and collodium is likewise left in its place until there is marked suppuration underneath.

Langenbeck asserted that defects of skin on the nose healed by granulation, leaving hardly a scar. Flaps might, therefore, be freely taken from the nose without fear of great disfigurement. Though there be, perhaps, no higher authority than Prof. Langenbeck on plastic surgery of the face, this assertion does not coincide with what I have seen in operations for epicanthus, when rhomboidal pieces of skin were removed from the back of the nose. They invariably left ungainly cicatrices.

I saw in Langenbeck's wards a case of replacement of the whole lower eyelid, after removal of a melano-sarcoma. The flap was taken from the cheek, downward from the temple, and transplanted with scarcely any twisting of the base, which, of course, was in the temple, just at the outer commissure. There was no swelling of the newly-formed lid, and no lachrymation.

Another remarkable operation I saw Langenbeck perform was the removal of a large epithelial cancer, which presented all the characteristics of the so-called "*rodent ulcer.*" It had destroyed both eyelids, the inner commissure, and a small part of the nose and cheek. The eyeball was likewise disorganized, and the nodules of the pseudoplasm were traceable some distance back into the orbit. Langenbeck believes, in opposition to English authorities, that the rodent ulcer is an epithelial

growth—viz., a cancer, for at the length of time it exhibits all its characteristic symptoms, and produces metastatic carcinomatous tumors in remote organs, for instance, in the uterus, as he has observed. He excised in this case all suspicious-looking tissue, together with the eyeball, and covered the whole defect by an unusually large flap from the forehead, with a rather small base—half an inch wide at most—lying between the opposite eyebrow and inner commissure. The sutures were rather far from one another—two to four lines—and none near the base of the flap, nor was the base stretched in any way. Langenbeck thinks it important not to interfere with the circulation in the base of flaps by stretching or sutures. The case resulted unfavorably. After-hemorrhage from the orbit occurred in the night after the operation. To stop it, some of the sutures had to be removed. They informed me afterward that the flap had sloughed. I was astonished at the scarcity of sutures also in Langenbeck's other plastic operations. Being in the habit of uniting flaps scrupulously, and probably doing too much, I prefer erring on the side of safety.

At *Breslau* I saw Prof. *Foerster* only for a short time. In Dr. *H. Cohn's* clinique there were many interesting cases, among which one of very extensive *xanthelasma of both eyelids.*

In *Vienna* I found Prof. *Arlt* untiringly busy. His clinique is still increasing, but his hospital wards are no longer adequate to the demands of the present day. Prof. *E. Jaeger's* department in the "General Hospital"

has of late been enlarged and much improved, especially the rooms for the out-door patients and the clinical and ophthalmoscopic courses.

At *Heidelberg* I found Prof. *O. Becker's* Ophthalmic Hospital in successful operation, with excellent arrangement for instruction, and an extensive collection of macroscopical and microscopical specimens.

In *Paris* I visited the Ophthalmic Institutions of Dr. *L. Wecker* and Dr. *X. Galezowski.* The former is beautifully fitted out, and does justice to the requirements of the age and the French metropolis. Among the many important objects I saw there, I mention a very successful case of *tatooing* of a *leucomatous cornea*, and a case of formation of *leptotrix fungus* in the lower canaliculus of a lady. I had an opportunity to see Dr. *Charcot* and some of the prominent French physicians at their work. There was a spirit of kindness, liberality, and earnestness about them that could not be surpassed by the great laborers in the field of science and humanity of any nation.

II. Notes on Otology.

James Hinton, in *London*, incises the membrana tympani between the long process of the anvil and the handle of the malleus in cases of *chronic collections of mucus and other morbid products in the tympanum.* Immediately afterwards he injects a weak solution of soda through a Eustachian catheter in the following

manner: He first introduces the catheter, then fills it with the soda lotion, by means of a small glass syringe; and forces the liquid with Politzer's bag into the tympanum and through the opening in the membrana tympani out of the ear. By this procedure hardened collections of mucus will frequently be evacuated.

Of late he prefers syringing in the inverse direction.

The nozzle of the syringe is mounted with an india-rubber ring, which fits tightly into the external auditory meatus. The head of the patient is bent forward so that the water which is injected into his ear runs out through the nose. He empties the syringe several times at the same sitting. In some instances the stream is checked, which seems to indicate that plugs of mucus have been thrown into the tube and obstruct it.

When the orifice in the membrana tympani closes, it must be reopened. The treatment will require at least two or three months.

The same mode of syringing he employs also in *perforations* of the tympanic membrane. After the syringing, he cauterizes the tympanum with chloro-acetic acid. This is a deliquescent crystallized substance which he keeps in a small bottle. He dips a moist camel's-hair brush into it and touches the mucous membrane of the drum *through the* speculum.

Hinton has discarded the hard ends of the *auscultation tube*, using simply an india-rubber tube, which sticks better in the meatus, conducts sound as well, and irritates less.

He treats granulations and small *Polypi* by cauterizing them with *chloro-acetic acid.*

He is fond of employing *Liquor epispasticus* (Collodium Cantharidum) behind the ears. He applies it himself in his consultation room by means of a brush, touching only a small surface at a time.

Hinton does no longer conduct steam, or medicated vapor, into the tympanum. He would dispose of all his steaming apparatus but for their historic interest.

I saw Dr. Peter Allen in his hospital clinique employ his modification of Politzer's air-bag. He has replaced the tube-like nozzle of Politzer's instrument by a double pad, which is pressed tightly on the nostrils. An opening in each pad leads the air into each nostril at the same time. He claims that the instrument, thus modified, has a great advantage in the treatment of children, who will not suffer a tube of any description to be introduced into their nostrils. To judge from some trials Dr. Allen was kind enough to make with myself, I fear his modification of Politzer's air-bag is less effective than the original apparatus.

I spent a week exclusively in studying *Toynbee's anatomo-pathological collection* at the Hunterian Museum, in the building of the College of Surgeons. It has been of great benefit to me, and if I were called upon to express my opinion on the value of this collection for the aural surgeon of to-day, I should fear no contradiction in asserting that *Toynbee's collection is the best and most extensive introduction into the deeper study of otology*

existing. It contains upward of 800 specimens, most of which are dry preparations. They are so varied that almost every stage of all the diseases of the ear is represented, excepting microscopic conditions, and the appearances of active inflammations, which can be demonstrated in fresh specimens only. The catalogue—unfortunately out of print—is excellent. Prof. Fowler, under whose supervision the museum is, kindly allows a careful visitor to open the cases and examine each specimen separately.

In *Dublin* I was received with great courtesy by the Nestor of modern otology, Sir Wm. Wilde. He is still in the habit of using his speculum without a reflector, turning the patient's ear towards a large window. The membrana tympani and adjoining parts of the meatus can be well examined in that way, although it be more convenient for most purposes to employ a mirror. I was pleased to see Sir William as active and enthusiastic as ever.

In *Glasgow* I saw good microscopic preparations of the cochlea, by Dr. Reid. Among them were some excellent transverse sections of the lamina spiralis membranacea, exhibiting beautifully the papilla spiralis, and the entrance of the fibres of the auditory nerve into it. Reid calls the papilla spiralis "papilla acustica sive colliculus acusticus," in analogy to the papilla optica. At this moment I do not recollect whether Reid traced the terminal fibres to some special parts of the papilla spiralis.

At *Halle* I had only some hours to spend in the society of Prof. *Schwartze.* I learned that he continues fully satisfied with his treatment of otorrhœa with strong solutions of nitrate of silver (ʒ β— ʒ i ad ℥ i).

Dr. *Hagen* of *Leipsic* employs the constant current on a rather extensive scale, and expressed himself well pleased with his therapeutic results. Dr. *Wendt*, of the same city, had the kindness to show me a fine commencement of a pathological museum of the ear. He has observed and studied microscopically some cases of diphtheria of the outer and middle ears; further, a great many of the changes caused in the middle ear by variola in children. They consisted in all possible stages of catarrhal and purulent otitis media, as well as destructive processes of the membrana tympani. His researches are and will be published in the "*Archiv für Heilkunde.*" I regretted that Dr. Wendt had purposely refrained from investigating the labyrinth in these cases, thinking it a subject still fraught with too great difficulties.

Prof. *Lucae*, of Berlin, employs frequently injections into the tympanic cavity, through the Eustachian catheter. He injects the usual astringent lotions of tannin and sulphate of zinc, to the strength of one to three per cent. The lotions are contained in small double-tubed glasses, such as chemists use under the name of "squirting bottles." An inflation apparatus with a double air-bag—like Richardson's nebulizer—is suspended at one of the button-holes of his coat, to be always near at hand. While introducing the catheter, Lucae holds the little bottle by

taking one of its glass tubes between his teeth, puts the other tube, by approaching his head, into the posterior orifice of the catheter when it is in place, blows a quantity of liquid out of the small bottle into the catheter, and forces it into the tympanic cavity with the double-bagged inflator, listening at the same time through the auscultation tube whether and how the liquid penetrates into the drum.

Lucae exhibited several cases illustrative of the usefulness of the interference otoscope, the method of application of which he has repeatedly described (*Archiv f. Ohrenheilk.*). He says that he is well satisfied with the following treatment of otitis media granulosa. He cauterizes the ear with sulphate of copper in substance twice a week, and lets the patient employ, at home, a one per cent. solution of the same remedy, dropped into the ear, and retained there for half an hour or an hour, by plugging the ear completely with an india-rubber stopper.

Fr. E. Weber, of Berlin, had the kindness to show me a few patients on whom he had performed tenotomy of the tendon of the tensor tympani muscle. In the cases where healing had already taken place there was hardly a scar visible, and the drumheads were freely movable. One young lady stated that both her hearing and tinnitus had been greatly improved by the operation. In one case the operation had been done only three days previously. The membrana tympani was red and swollen, but no serious inflammatory symptoms were present. On the

fourth and fifth days, Dr. Weber added, the reaction was ordinarily more marked.

I saw *Weber* introduce elastic probes through a Eustachian catheter into the drum in order to dilate strictures of the tube. He introduces also thin elastic catheters through silver Eustachian catheters into the tympanic cavity, to serve for injecting liquids, and to remove serous, mucous, and puriform accumulations from that cavity, by suction. Though some of Dr. Weber's proceedings impressed me as not yet being durable acquisitions to the science and art of aural surgery, I found him an energetic and initiative practitioner.

In Prof. *Lewin's* hospital department—syphilis and diseases of the throat—I had an opportunity to see many useful diagnostic and therapeutic applications which have some relation to ear diseases. He demonstrated, among other things, that intumescences of the tonsillæ pharyngeæ are far more common than is generally supposed; furthermore, that in pharyngo-nasal affections there are frequently found roundish swellings of the mucous membrane of the nasal passages, in the shape of small tumors, perhaps of a polypoid nature, but less persistent than polypi.

He uses chromic acid for cauterization. He says that it acts like ferrum candens, burning the tissues by giving off oxygen. Some chromic acid injected into the tissue or abscess holes of hypertrophied tonsillæ causes these to shrink in a very satisfactory manner.

Lewin continues subcutaneous injections of sublimate in syphilis, and prefers them to the other methods of ad-

ministering mercury. Among the peculiarities of the treatment with Hg., he spoke of the occurrence of diarrhœa mercurialis, which is as apt to follow the subcutaneous injection of bichloride of hydrargyrum as the employment of other mercurial preparations. It is treated in the same way by opiates.

From one of *Virchow's* lectures, to which I had an opportunity to listen, I may be allowed to quote the following sentence as bearing on the subject of deafness in consequence of meningitis, or from primary otitis intima (Voltolini). The great pathologist said: "I will here not pass over in silence an article of my creed, of which at other places I have not made a secret either, *i. e.*, that miliary tubercles in the pia mater may disappear by resolution through the medium of fatty degeneration. It is, indeed, striking that in the pia we nearly never meet with cheesy productions, whereas they are frequent in most other organs. Arachnitis tuberculosa is fatal in a very much greater proportion than the ordinary meningitis. The reason is that the depressions between the gyri become principally affected, producing a participation of the adjacent substance of the brain in the way of simple inflammation." This certainly shows that Virchow thinks meningitis not an absolutely or almost absolutely lethal disease. The contrary supposition is one of the main arguments of Voltolini to pronounce such cases in which deafness occurs under severe cerebral symptoms, to be idiopathic inflammations of the labyrinth in lieu of meningitis.

Prof. *Voltolini*, of Breslau, injects liquids (KI) into the tympanum by means of a silver catheter, a drop-glass, and an air-bag.

He introduces bougies through silver catheters into the tympanum, and keeps them in position with a holder. The holder he uses has a pad, which is pressed upon the forehead by means of a band passing around the head. Attached to the pad is a kind of pincers, consisting of two iron branches, which open by pressure and are closed by a spring. In their grasp the catheter is held.

He says he has noticed sometimes marked diminution and even disappearance of tinnitus aurium by the use of the constant electric current, but never any improvement of hearing. He uses a small portative apparatus, by Krüger and Hirschmann, of 20 elements, without a rheostat, and without peculiar electrodes for the ear, placing the wire immediately into the meatus, which is filled with water. The patients complain of pain. He showed me a young lady who was hard of hearing, but had lost by this method her tinnitus aurium completely, when six weeks afterwards it reappeared on both sides immediately after the introduction of a bougie into the tympanic cavities, and since then had not yielded to the current.

Dr. *Voltolini* and Dr. *Jacoby* employ galvano-caustics for the destruction of polypoid and other growths in the ear and the nasal and pharyngeal cavities. Their apparatus are mainly those of the late Professor *Middeldorf*, of Breslau, with some modifications to adapt

them specially for the regions mentioned. I saw several patients treated in that way, and convinced myself of the advantages of this method. The operations were nearly painless, so that children under twelve years supported the destruction of polypi in the tympanic cavity without moving their heads. The electro-cauter is introduced into the ear, applied to the proper place, then brought to a white heat almost in a moment, and the destruction of the growth is made before the patient is aware of the hissing noise resulting from the combustion. When a metal is at white heat, the heat is so intense that the animal tissues brought in contact with it are instantly destroyed, and no pain is felt. Red heat, being much less intense, does not act with the same rapidity, and is accompanied with pain when applied to the tissues of the body. It is, therefore, important to have the battery of such power as to bring the electrodes instantly to a white heat. Another advantage of galvano-caustics over the other modes of cauterization is the precision with which the instrument can be brought to the desired place. Being cold, it does not injure the auditory canal or any portion of the middle ear during its introduction, and as soon as the effect is obtained and the current interrupted it cools with astonishing rapidity, so that no injury is done either when it is withdrawn. That no hemorrhage occurs is a great advantage of the galvano-caustic method, but too well known to be dwelt upon.

Voltolini uses galvano-caustics also to perforate the membrana tympani. I witnessed one of these opera-

tions. It was quickly done, and without notable annoyance to the patient. The aperture was round and well-defined. Voltolini seems to believe that openings made in that way do not close so readily as those made with the cutting instrument.

Voltolini showed me excellent microscopic preparations of the cochlea, which were only equalled and surpassed by those of Prof. *Waldeyer* and Dr. *Gottstein*, of Breslau. These gentlemen have made transverse sections through the lamina spiralis, which display every layer with diagrammatic nicety. The acoustic nerve fibres, tainted with chloride of gold and hyperosmic acid, could be distinctly traced from the habenula perforata to the cells of Corti and Deiters below the membrana velamentosa s. reticularis. Waldeyer has described his researches in Stricker's Cyclopedia of Histology, and Gottstein will soon publish the result of his investigations in Max Schultze's Archives of Microscopic Anatomy.

In Vienna, where I stayed three weeks, I had the misfortune to miss Prof. Politzer, who was absent on a journey of vacation. I was, however, indemnified by the abundant clinical and private material of important cases which Prof. *J. Gruber* showed me and put at my disposal with great complacence. Gruber is an energetic practitioner. He performs paracentesis of the drum frequently. He has devised an instrument for tenotomy of the tensor tympani which is similar to a paracentesis needle, only longer and bent on the flat. One

case of paracentesis interested me a great deal. It was that of a young woman, whose drumhead was perforated in its anterior half and bulging in the posterior. Inflation and syringing had no influence on the bulging portion, which looked white. Gruber perforated it with the needle, and by syringing brought out a considerable amount of puriform substance. The case rapidly improved afterward. For inflation he uses the catheter by preference, rarely the air-bag, which he employs according to Politzer's plan. He frequently makes injections into the tympanum, either through the Eustachian catheter in the ordinary way, or by his own method, which consists in injecting the liquid into one nostril while the other is closed with the finger. The fluid then finds its way through the Eustachian tube into the drum of the same side, and often enough through both tubes into both drums. That the fluid enters the tympanic cavities readily, I have satisfied myself by the auscultation tube during the injection, and by the speculum afterward. The question only is, whether the quantity of injected fluid can be as accurately ascertained and measured in this method as in that of injecting it through the Eustachian catheter, and I fear that too great a quantity of fluid is liable to enter the tympanum. *Gruber* commonly uses and highly recommends, in chronic swellings of the walls of the external auditory canal, pledgets of lint besmeared with red precipitate ointment, which are introduced into the canal and kept there for some hours every day.

He employs his oval metallic specula in preference to

all others. They give a better light than the black, hard-rubber specula, and when rotated a little become self-retaining, so that operations may be performed through them without an assistant to hold them.

In deafness and tinnitus without appreciable lesion in the outer and middle ears, I saw him prescribe the following formula:—

℞ Spirit. formic................ ʒ ij.
Æther. sulph.
Chloroform.................āā ʒ j.

M. D. S. To be poured upon cotton wool and put into the ear every evening.

I saw a number of rare cases in Gruber's Clinique, and many instructive specimens in his extensive pathological collection, of which I shall not speak here, anticipating their description by Dr. Gruber himself.

During the university vacation, I could avail myself to the fullest extent of the magnificent opportunity afforded by the Pathological Institute to obtain anatomical specimens of the hearing apparatus, both physiological and pathological. Prof. Rokitanski and his assistants, Drs. Kundrat and Fleischl, placed the "colossal" material of the post-mortem room of the "Allgemeine Krankenhaus" unreservedly at my disposal for this particular purpose. Besides numerous normal preparations, I was able to collect a certain number of pathological specimens, illustrating different stages of purulent otitis, adhesions in the middle ear, caries of the temporal bone, thrombosis of the lateral sinus and jugular vein,

metastatic pyo-pneumothorax, exhibiting the perforations of pyemic abscesses into the pleural cavity, and different other remarkable conditions. If a student wants to study pathology of the ear, Vienna is the place to do it.

In *Heidelberg* I saw a great many interesting cases and anatomical specimens in the consultation room and collection of Prof. *S. Moos*. Since he, as the co-editor of these Archives, will not omit to publish them by and by, I shall not anticipate his communications. One observation, however, I may here mention. Moos has examined the hearing organ of persons who died of typhoid fever, who had been hard of hearing, and examined by him during the disease. Besides changes in the middle ear, he found an inordinate infiltration of the membranous labyrinth with lymphoid cells, which seems to denote an initial state of purulent otitis interna. Moos removes the membranous labyrinth from the bone by means of two needles, like those used for the reclination of cataract, one of which, however, is bent at an obtuse angle. Available surface preparations can be obtained in this manner without softening the bone, and fresh specimens made accessible to the investigation with the microscope.

III. Report on the Transactions of the German Ophthalmological Society.

(*Translated from the German by* Dr. C. S. Bull, *of New York.*)

As an appendix to the foregoing notes, a report of the German Ophthalmological Congress, held at Heidelberg on the 4th and 5th of September, may not prove uninteresting. The meeting was as well attended this year as ever before, about 70 members being present. The following report is compiled from my own stenographic notes taken during the sitting of the congress. I may be pardoned some imperfections, and perhaps here and there an incorrect statement, if it be remembered that during the discussions I was no mere writing machine, but was constantly endeavoring to make everything that I heard as clear to my own mind as possible.

Prof. Von Arlt opened the sitting with words of deepest feeling for the late Prof. Von Graefe, the founder of the Society, after which the scientific discussions began under the presidency of Prof. Donders, his place being taken on the second day by Prof. Schweigger.

Dr. Berlin, of Stuttgart, spoke of *division of the optic nerve.* The examination of three eyes, in which the retina was torn off at the optic nerve, and showed numerous changes—atrophy, extravasation, and pigmentation, induced him to make some experiments pointing to the same end upon animals. His experiments were mainly upon frogs, and to a less extent upon rabbits, as the operative difficulties are here more considerable. He

reached the same results in both species. He divided the optic nerve from the outside, by which means the arteria ophthalmica, as well as the arteria centralis retinæ, were simultaneously cut. The success of the operation may be determined with the ophthalmoscope, by the fact of the choroid losing its color. The blood in the veins of the hyaloid membrane moves to and fro, dependent upon the respiratory movements, until in a few days the normal circulation is re-established. The pupil contracts immediately after the operation, but after the third day again dilates. From the second day on, marked changes in the fundus are perceptible; the latter becomes of a grayish-white, milky color, the blood-vessels remaining distinctly visible. The retina is streaked very perceptibly in a radiating manner. The examination of the eyes, which was made at a varying length of time after the operation, showed the nerve-fibres to be granular, and the retina attenuated, particularly at the expense of the fibrous, ganglionic, and molecular layers. The fibres of Müller resist the longest, and the rods always remain uninjured. The extent of the atrophy varied in different portions of the same retina. Throughout the whole retina, the deposit of pigment was very large. This was accompanied step for step by a corresponding decolorization of the choroidal epithelium, and hence was dependent upon the latter. No signs of inflammation of any kind, appeared during the process of atrophy and pigmentation. Dr. Berlin emphasized the importance of continuing the experiments, and remarked that in ad-

dition to the above-mentioned morbid processes, many others might be experimentally followed out in this manner, especially extravasations, concerning whose appearance and course he had already made some valuable observations.

Dr. Von Wecker, of Paris, spoke of *sclerotomy as an operation for glaucoma.* It is believed by many operators that the essential part of the operation is the incision in the sclera, and not the excision of the iris. Quaglino has performed sclerotomy, and published five successful cases. He passes the knife through the sclera into the anterior chamber close in front of the iris, and after the knife has been withdrawn, prolapse of the iris sometimes occurs. Wecker does not prefer sclerotomy to iridectomy, but thinks that experiments with the former are desirable; he himself does the operation upwards with Graefe's narrow knife. He does not cut through the central portion of the scleral wall lying in front of the knife, but allows the aqueous humor to trickle out carefully, and only withdraws the knife when there is no longer any fear of a prolapse of the iris. His experience has not been large enough to allow of a decision upon the value of the operation. He called attention to the absence of all danger in the operation, and reminded the society that an iridectomy could be performed at any subsequent time.

H. Cohn, of Breslau, spoke of the results of a *new examination of the refraction and acuity of vision of* 240 *children in two village schools.* He first paralyzed the

accommodation of the right eye of all the children with atropine, and 14 days later that of the left eye also. All the children showed $V = \frac{20}{20}$ with the right eye, before the instillation of atropine. 212 were emmetropic, 28 ametropic, and of the latter somewhat more than 1 per cent. were myopic. After the accommodation was paralyzed, he found as an average $\frac{1}{52}$ hypermetropia, and only one child remained emmetropic. The age exerted no influence upon the occurrence of the hypermetropia.

In the second examination, Cohn determined the acuity of vision of 100 children before the instillation of atropine. He employed Snellen's tables for determining the vision for the distance, and used the open squares when the children could not read. In seven children was $V = \frac{20}{20}$ only, but in all the others it was considerably higher, up to $\frac{60}{20}$.

He also examined the power of color-perception in all the children, and did not find a single case of color-blindness.

Dr. Schulek, of Vienna, remarked that higher values were obtained in determining the acuity of vision when Snellen's open squares were used than by the employment of letters, and in this Arlt agreed with him. Woinow on the contrary questioned this statement, and asserted that the results remained the same in both methods of examination.

Prof. Horner, of Zurich, spoke of "*herpes zoster ophthalmicus*" and "*herpes zoster corneæ.*" The latter affection has never been correctly defined, and is by no

means identical with the phlyctenular keratitis, which is described by Stellwag under the name of "herpes corneæ." The "herpes zoster corneæ" begins with collections of clear vesicles, arranged in the form of a wreath upon the cornea. After these rupture there appears an irregular loss of substance beneath, as if it were the result of a scratch. The cornea soon becomes opaque, and is usually insensible throughout its whole extent. The course is slow, and the regeneration of the epithelium especially is very gradual; the tension of the globe is moreover markedly lessened. The retina is the seat of venous hyperæmia. There is another form of the affection very similar to the one just described, but in which the tension of the globe and the sensibility of the cornea are not especially altered. Horner observed 31 cases of herpes corneæ in the course of the year, and in many there was present at the same time herpes of the lips and cheeks. In most of the cases the affection of the eye was preceded by some general constitutional disorder, as pneumonia, intermittent fever, or the like. The average age of the patients was 35 years. A few cases were cured in two weeks, but the most lasted 1½ to 2 months. The disease is with rare exceptions monocular, and manifests no tendency to complications with iritis nor to recurrence.

Nagel saw the same complication of symptoms in a case where there was but a single vesicle. The case healed rapidly under the application of the constant current, after other means had been tried in vain. Horner

had also seen cases where the vesicles appeared in the centre of the cornea, and were few in number. As regards the treatment of herpes zoster corneæ, Horner spoke as follows: "Hypodermic injections of morphia are to be recommended for the purpose of allaying the pain, and the opening of the vesicles somewhat lessens the pain also. Von Graefe, from a verbal communication, was accustomed in this affection to dust calomel into the eye. Warm poultices act unfavorably, but a protecting bandage and instillation of atropine are on the contrary to be recommended. Wecker called attention to the occurrence of very small vesicles of herpes upon the cornea. Berlin had sometimes observed detachments of the corneal epithelium in the form of large vesicles, involving about $\frac{1}{6}$ of the epithelium of the cornea. Arlt and Berlin mentioned that low degrees of mydriasis and paralysis of accommodation were frequently complications of herpes zoster.

In regard to herpes zoster ophthalmicus, Horner remarked that in the stage of swelling the sensibility of the skin diminishes, and for two months afterwards the temperature of the skin upon the affected side was about 2° higher than upon the other, and was only equalized at the end of one and a half months longer. Donders observed an abundant secretion of perspiration in a case of anæsthesia of the skin of the forehead, and here it was difficult to measure the temperature. He employed the differential thermometer, as this instrument only requires application for a few seconds. Nagel had observed

several times an inflammation upon the corneal margin, complicated with diminution of tension; the affection was cured in a few weeks by the employment of warm applications. Horner stated that a post-mortem examination was recently made upon a case of herpes zoster, and that marked disease of the Gasserian ganglion was observed, but none of the nerves. The case was to be described more in detail.

Prof. Förster of Breslau spoke of the *power of the perception of light in diseases of the retina and choroid.* His investigations were performed with the aid of an apparatus which consisted of a box blackened upon the inside. In the interior face of this box are two small tubular openings, through which the patient is to look, and an opening covered by transparent paper, the size of which is capable of being altered, in front of which the "normal candle" is placed. Upon the internal surface of the posterior side of the box, white lines are drawn upon the black back-ground. The intensity of illumination was at first diminished by lessening the source of light, *i. e.*, the size of the white paper illuminated by the candle, until normal eyes could recognize the white lines distinctly, and by these means it was demonstrated that the surface of illumination for the normal perception of light amounted to two square millimetres. Förster next examined patients with various affections of the eyes, and found that in the following diseases the annexed numbers, representing the intensity of light measured by

square millimetres, were necessary in order to render the white lines distinct :—

Atrophia nervi optici	2–8–10
Hemiopia	6
Retinitis morb. Brightii	2–4
Neuritis optici	2–8
Amblyopia e potu	2
Ablatio retinæ	312–1650
Retinitis pigmentosa	40–800
Choroiditis syphilitica	128–1624
Choroiditis disseminata in exacerbatione	112–450

These results show two groups of diseases very different from each other as regards the diminution of the sense of light-perception. Those affections of the retina in which the fibrous layer is especially affected, require but a trifling increase in the intensity of illumination: but on the other hand the diseases of the retina in which the choroid participates, or which are dependent upon choroidal diseases, require a very much greater increase in the illumination. The amblyopic patients affected by diseases of the latter group therefore complain particularly that they see very much worse by dim light; while those patients who assert that they not only do not see worse, but sometimes even better by a low degree of illumination, all belong to the first group.

Dr. Hippel, of Königsberg, and A. Weber, of Darmstadt, showed *apparatus for determining the sense of light-perception of the eye.* Hippel diminished the illu-

mination by allowing it to pass through a varying number of dull glass plates, in front of which he passed tin disks out of which letters were cut. The greater the number of glass plates that could be introduced before the letters became illegible, so much the less was the intensity of illumination, and therefore so much the greater was the sense of light-perception of the eye examined.

A. Weber likewise employed several dull glass plates placed one upon the other, but used them as a source of light in order to illuminate Snellen's tables. The diminution of the intensity of illumination rendered possible by this arrangement, can in his opinion be made very valuable.

Dr. Schulek, of Vienna, exhibited a *compact case of glasses, which contained but* 8 *convex and* 8 *concave numbers.* The combination of two or more glasses gives the numbers not contained in the box. The case was to be recommended on account of its cheapness and compact form, and would be especially useful for the general practitioner.

Prof. Leber, of Göttingen, spoke of the *permeability of the cornea*, and of the mode of exit of the aqueous humor. It is plausible to assume that the anterior chamber is a lymphatic space. Leber increased the tension of an enucleated eye and afterwards found the cornea always dry, while the conjunctiva was moist; from which it must be concluded that the fluid does not pass through the cornea, but through the limbus conjunctivæ. He next employed colored fluids, and found

that when a neutral carmine solution was injected into the anterior chamber, and the intra-ocular pressure increased, the episcleral veins were beautifully injected. If mixtures of Prussian blue and a gelatinous substance with carmine were simultaneously injected into the anterior chamber, the episcleral veins were colored red; and hence it might be inferred that no open communication exists between the vessels and the anterior chamber, and that the fluid percolates through. Leber disagreed with Schwalbe, and maintained his former opinion that the canal of Schlemm is a plexus-like venous sinus. He also instituted some experiments with the membrane of Descemet alone, and found its permeability extremely slight: hence he infers that it protects the cornea by preventing the exosmosis of the aqueous humor.

Dr. Woinow explained the manner in which he *examines for color-blindness.* He employs a Maxwell's apparatus,—very well made by the optician Zimmermann, in Heidelberg—and upon its rotating disk he arranges the colors in such a manner as to bring white and black in the middle; and the other colors, especially the prime colors, red, green, and violet, in the periphery. A person who is color-blind may combine his own scale of colors, *e. g.*, a person who is red-blind, from green and violet. When the peripherical ring appears exactly like the centre, it shows the missing color.

Prof. O. Becker, of Heidelberg, spoke of the occurrence of the *arterial pulsation in connection with cardiac disease*, and demonstrable by the ophthalmoscope. When

insufficiency of the aortic valves complicates insufficiency of the mitral valves, the arterial pulsation does not occur; but when hypertrophy of the left ventricle is also present with the latter, the pulsation of the retinal artery occurs just as in insufficiency of the aortic valves complicated with hypertrophy of the left ventricle. Even in the normal state a kind of circulation may be observed upon the papilla which is connected with the general circulation; especially do we see the artery influenced by a neighboring vein. Prof. Becker also discovered an arterial pulsation in three healthy individuals. In one case the artery passed undivided to the border of the papilla, and here divided suddenly into four branches. The resistance was here so considerable that the differences in tension in the papillary portion of the vessel caused a pulsation. In examining recently a large number of patients in the general hospital of Vienna, suffering from cardiac disease, Becker found an arterial pulsation in the left eye of a patient who was suffering from an aneurism of the carotid, but not in the right eye. He also found an arterial pulsation in a case of partial detachment of the retina, probably in consequence of a tumor.

Dr. Woinow spoke of *wheel-rotation of the eye.* Dr. Screbitzky found 1° of compensating wheel-rotation for 10° of lateral inclination of the head; Nagel 1° for 6°. Woinow instituted experiments upon the same object for distant and near vision, and found that in his own eyes the convergence exercised no influence upon the rotation; but in others whose vertical meridians diverged upwards

for near vision, this influence did take place. He examined a number of such individuals, and found that the same proportion between rotation and lateral turning constantly existed in them. He could also prove the existence of rotation by the ophthalmometer, by the fact that the radii gained by turning the mirror round a fixed angle were different from those gained by inclining the head to the same angle.

Donders found in his own eyes 1° of compensating rotation for 8° of inclination of the head.

Prof. Nagel, of Tübingen, spoke of the use of *strychnine in disturbances of the muscular apparatus.* In cases of muscular and accommodative asthenopia he had had good results from the use of strychnine. It also had proved advantageous in cases of spasm of the accommodation and of the recti interni. Nagel gave a detailed account of a case of spasm of accommodation, which appeared under the form of an amblyopia.

A boy, twelve years of age, had professedly become myopic within a year, and complained also of pain and fatigue in the eyes. Concave glasses No. 3 brought the diminished visual power up to nearly $\frac{20}{20}$. With —6 he read Jaeger No. 1 at 5″—6″, while with the naked eye he could only read the largest type near by. He read Jaeger No. 1 easily near by with convex glasses, and colored glasses produced an agreeable effect. He had convergent strabismus for all the higher grades of accommodation. After instillation of atropine he read one number higher as each minute passed by, and when the drug had produced its complete effect he read $\frac{20}{30}$, still better with +40; but when the effect of the atropine had passed off, the spasm returned. One application of Heurteloup's leech removed the spasm completely with all

its annoyances, but in the next few weeks there was again a slight return of it, and after six months it returned in its entirety. The boy had previously suffered from epistaxis and hence Nagel tried the injection of strychnine instead of the artificial leech. After one injection the affection of the eyes almost entirely disappeared, and by a second injection a complete and permanent cure was obtained.

Nagel had observed some such cases, and therefore from his own experience recommends *strychnine as an antispasmodic also.* He injects from $\frac{1}{30}$ to $\frac{1}{20}$ of a grain.

Prof. Dor, of Berne, announced that he had come to an agreement with a glass manufactory for obtaining the glass vessels introduced into London by Dr. Bader for the preservation of eyes. The establishment would furnish them at a much cheaper price if a large number were previously ordered, so as to indemnify it for the manufacture of the forms. Most of the members of the Society subscribed their names upon the order-list which was passed round, and notice was given that if any one wished further to interest himself in the matter, he needed only to inform Prof. Dor in Berne of the number of glasses he wished.

Prof. Rothmund spoke of the *development of cysts of the iris*, and mentioned as introduction the following case from his own practice:—

A man had been wounded in the eye by a sharp piece of iron, and this was followed by symptoms of iritis. The pupil was irregular, and the iris became adherent in the corneal cicatrix in the form of a black line. In endeavoring to detach it from the wound by means of Sichel's spoon, he extracted four eyelashes from the cicatrix. All signs of irrita-

tion had passed away at the end of the 8th day; but $2\frac{1}{2}$ years later the patient presented himself again, and stated that up to six weeks previously his vision had been perfectly good, at which time he suddenly became entirely blind! On examination a cyst, about the size of the lens, was found in the anterior chamber, and was removed "in toto" by Prof. Rothmund. It consisted of epidermis-cells and cholesterine.

Two similar cases are known; one of Von Graefe, which also proceeded from an eyelash. Prof. Rothmund distinguishes two forms of cysts of the iris, epithelial and serous. The first he considers to arise from portions of the cutis having penetrated the eye: the serous cysts lined with epithelium admit of the explanation that portions of the corneal epithelium might possibly slip into the iris. He spoke also of Wecker's hypothesis of the origin of cysts by sacculation of fluid, etc. Prof. von Arlt had observed about four cysts of the iris; all were of the serous variety, were the consequence of wounds, and proceeded from the periphery of the iris. He operated in the following manner: he passed a lance-shaped knife into the cyst, the contents flowed out and its walls fell forward, so that he could seize the cyst and draw it out.

Wecker agreed with *Rothmund* in regard to the origin of cysts of the iris. One variety he considered to be the analogue of skin-grafting, and the other he regarded as the result of a sacculation of fluid. He thought he was not deceived in assuming that cases could also occur without traumatic origin. *Arlt* stated that the cases operated upon by him had remained cured as long as he

had heard from them. *Knapp* mentioned three cases which he had observed in New York, one in his own practice and the other two in the practice of other physicians. The case operated upon by him, and published in the Archives of Ophthalmology and Otology, required a second operation two weeks after the first, but had up to date shown no tendency to return; although a year afterwards the patient was attacked, after a severe cold, by an acute, circumscribed choroidal inflammation in the other eye, accompanied by exudation, from which, however, she recovered without injury. In one of the two other cases the operation (excision) led to destruction of the eye, in the other to permanent cure. *Critchett* remarked that five cases which he had observed all finally ended in loss of the eye. *Horner* mentioned a case treated by him, in which he caused a prolapse of the cyst through a corneal incision with a lance-headed knife, without having penetrated the cyst-wall. *Nagel* related a case of a large cyst, which he extracted at the same time with a cataract. The amount of vision obtained was not great, but still no signs of sympathetic irritation afterwards appeared. *Schweigger* had observed in one case six eyelashes in the anterior chamber. Three of these he removed, but the other three developed into small white tumors, which were examined by *W. Krause* after their removal and found to be atheromatous. Schweigger agreed with Krause that portions of the cilia near the roots of the hair, or cilia with the roots of the hair attached, might have given rise to the tumors.

Dr. Schulek called attention to some observations which he had made upon 27 cases of *divergent squint* at the eye-clinic of Vienna. In none of these eyes, even with the greatest amount of abduction, did the cornea pass beyond the outer commissure. There therefore existed no increase of motion outwards, but on the contrary there was a varying diminution of motility inwards. The range of excursion was therefore not shifted in position, but really limited. Accommodative convergence was varying in different positions. There was no pure concomitant strabismus divergens, and the motility was not changed by tenotomy of the external rectus. The speaker regarded the strabismus divergens as a passive condition of the internal rectus muscle, and therefore advised the advancement of the latter muscle. *Knapp* remarked that in high degrees of divergent squint he was accustomed to combine the tenotomy of the external rectus with advancement of the internal rectus, and that he had seen other operators proceed in the same manner. Remarks were made by many of the members concerning the manner of proceeding in advancement of the muscle, and it was the general impression that almost every one performed the operation after an "ingenious and efficient" method of his own.

Dr. *H. Knapp*, of New York, spoke of *blepharoplasty*. [He, as the writer of these lines, begs leave to insert his own paper, not in the form of a report, but of a verbal communication, though considerably condensed.] The excuse I have for mentioning this subject here, rests

upon the ground of some recent experience which I have had of late years. I have obtained the best results by the method of *stretching the flaps*. I published a case in 1867 in the Archives of Ophthalmology (Vol. XIII., 1). It was a case in which the loss of three-fourths of the lower lid had to be repaired. Since then I have operated by the same method upon similar cases, and the result left nothing to be desired. The new lid covered the globe, was not swollen, allowed the complete and easy closure of the palpebral fissure even in sleep, and there was no lachrymation. But although this method produces very excellent results, it is limited in its efficiency, and I have not yet ventured by its means to repair the loss of more than $\frac{3}{4}$ of the lower lid. The external flap may indeed extend over the whole temple, and the incisions for the formation of the inner flap may also be carried beyond the bridge of the nose without there being any fear of a slough taking place, for the base of the flaps may be made as broad as desired. But it may happen that the vertical line of union between the two flaps does not heal by first intention. This was partially the result in one of my cases, in which the two upper sutures gave way. The resulting injury is, however, not great, as the coloboma of the lid may be remedied by a subsequent operation.

I have recently employed the method of stretching for the formation of the inner angle of the lid. The external (inferior) flap was obtained by dissecting up the remains of the lower lid by incisions carried over upon the temple,

and the upper (internal) flap formed by incisions carried transversely over the root of the nose into the glabella. The more the flaps are stretched and extended, the more difficult it is to maintain their nutrition. I am very careful in measuring off the base and thickness of the flap, since by this method the first can be made as large as desirable. As both flaps would bridge over the cavity of the inner angle of the lids, when union takes place in the usual way, I avoid this by passing the sutures at the same time through the periosteum, or through the superjacent connective tissue. The result of such an operation was excellent. I have never yet employed the method of stretching upon the upper lid, as a displacement of the tendon of the levator palpebræ superioris would interfere with the mobility of the new lid. For the formation of the external angle of the lid, however, it might frequently be found efficient. I have always undertaken the formation of the upper lid by the ordinary transplantation of a frontal flap over the eyebrows; the base of the flap lying either upon the temple or between the eyebrows, as appears most convenient.

I also undertake, when possible, the formation of the entire lower lid, together with an angle of the lid by transplantation of a flap from the forehead. I choose the upper flap, in order to obtain an upward traction when the contraction afterwards sets in, which opposes the tendency to the formation of an ectropium. As a rule, a secondary operation is required at the angle. In one case I had to supply the external commissure, a third of

the upper lid, and almost the entire lower lid; and here I formed a large flap from the forehead, its broad base lying on the temple. After healing it covered the entire defect, but also the palpebral fissure somewhat beyond the external corneal margin, and at the external commissure it was considerably swollen. In order to do away with this inconvenience, I did an operation for blepharophimosis: I cut transversely through the new external commissure with a strong pair of scissors, as far as the external bony wall of the orbit. Then, by means of a narrow knife, I removed the entire fibrous basis of the swollen flap for a thickness of about 2‴, so that a large cavity was left between the skin and the conjunctiva, which was removed by uniting the two by fine sutures. The success was complete.

When the defect in the lower lid was not too great, I formerly used to form the flap from the cheek, or resorted to the lateral sliding of a quadrilateral flap after the manner of Dieffenbach. Of late years I have avoided this procedure, on account of its strong tendency to cause ectropium, by endeavoring to give to the subsequent contraction of the flap a purely lateral direction, or else one acting from below upward. The method of stretching lateral flaps, or flaps directed laterally and upwards, ought generally to be a favorable exchange for these methods.

When the *defect is very great*, we must resort generally to a *combination of several methods*. I have employed the method of B. von Langenbeck, of replac-

ing the upper lid by a flap taken from the forehead and transplanted over the brow, and the lower lid by a similar flap from the cheek, while the approximation and partial union of these two flaps at the same time formed the external commissure. The result was good, and I therefore recommend the operation. In one case of almost complete loss of the upper lid, total loss of the lower lid, and destruction of the lachrymal sac, I replaced, a few months ago, the upper lid by a flap from the forehead, the base of which lay between the eyebrows and the opposite side of the root of the nose, and the lower lid by a flap from the cheek, after the manner of Dieffenbach, but prolonged further upon the temple and the region of the lachrymal sac by a sliding flap from the nose. The line of union of the three flaps formed the inner commissure. The vacant spaces left by the transplantation of the flaps, particularly the one upon the forehead, were covered by drawing together the skin in various directions, previously dissected up from its attachments, and introducing quilled or figure-of-eight sutures, as well as interrupted sutures. Although the wound was very extensive, it healed without suppuration. In a blepharoplastic operation, I regard a broad base and exact coaptation of the flaps as much more indispensable than in most of the other plastic operations. I introduce the sutures very closely together, using for the purpose very fine China bead-silk, and I do not begin to insert them until the hemorrhage has entirely ceased. The patient should afterwards remain quietly in bed with both eyes closed in

order to avoid as much as possible any movements of the flaps. By following out carefully these and other precautions, I have for years seen no sloughing of the flaps occur, although I perform comparatively a large number of plastic operations upon the lids, having done eight during the past year. Finally I would remark, that in cases of simultaneous formation of the lower and upper lids, the flaps must be large enough to lie in contact with one another along the palpebral fissure after the completion of the operation. The subsequent contraction will give a sufficient opening to the fissure.

Hermann Pagenstecher, of Wiesbaden, spoke of several *anatomo-pathological conditions of the eye;* first, of the occurrence of *retinal tumors with short pedicles.* Those which he had examined proceeded from the retinal vessels and generally were real vascular loops, which were afterwards gradually transformed into masses of connective tissue. He macerated the retina in Liquor-potassæ, which isolates the vessels. The vascular loops which develop into tumors are generally arterial, lie at first in the thickness of the retina, but gradually protrude beyond its level, without, however, causing any essential changes in the structure of the membrane. He also showed a preparation of a considerable *formation of bone in the eye*, which followed the ordinary type. The lens was calcified. He also showed an eye with *congenital absence of the iris.* The ciliary body sent out a process to the cornea which was covered with epithelium.

Dr. Mannhardt, of Rome, spoke of the *power of convergence,* and considered it as determined by three factors: 1st, by the primary position, facultative convergence; 2d, by the size of the angle; and 3d, particularly by the distance of both eyes from each other.—He had examined many persons and had arrived at not unimportant results, but would only mention the following: The absolute size of the angle of convergence is tolerably constant, 24°. In strabismus convergens the angle of convergence is larger, in strabismus divergens it is smaller. Myopia only appears as a constant complication when the anatomical relations render convergence difficult. Tenotomy he regards as the means of stopping the increase of myopia.

Dobrowolski spoke of measurements for determining the *distance of the yellow spot from the papilla* by means of Förster's perimeter. Knapp remarked that since it had been represented that by means of such functional examinations the actual distance of the macula lutea could be ascertained, and that the statement had been made that the macula lutea is nearer to the papilla in highly myopic eyes than in others, which is contradicted by anatomical facts, the method for such measurements was not applicable, as it only determined the projection of an oblique surface, but not the actual extension. The more obliquely the surface is inclined to the visual line and the more myopic in general is the eye, so much the greater will be the source of error. The elliptical appearance of the disc of the optic nerve of myopic eyes seen with the

ophthalmoscope is to be explained in the same manner. Dr. Wecker, of Paris, laid before the society the results of the examination of 116 *cases of squint.* He found that in young persons the strabismus is usually convergent, and he had frequently observed a spontaneous cure of this form of squint. He inferred from his experience that the same tendency to divergence afterwards appeared also in those cases of convergent strabismus combined with hypermetropia which had undergone operation, which may be the reason why so many of the cases formerly operated upon, now present themselves to us under the form of divergent strabismus. In alternating strabismus this may generally be prevented by the good acuity of vision. He therefore recommended great care in the operation, and thought it better to allow a slight degree of convergence to remain than run the risk of occasioning a subsequent divergence.

Dr. Cohn, of Breslau, related the following case: A soldier was wounded by a shot in the superior margin of the orbit. An examination with the ophthalmoscope afterwards discovered a large white spot in the fundus, about the size of 8–10 diameters of the disc, which he at first regarded as a rupture of the choroid, but afterwards as an exudation into the choroid. After some time sympathetic irritation appeared in the other eye, and the injured organ was extirpated and examined microscopically. It showed atrophy of the choroid and a dense white exudative membrane throughout the whole extent of the white spot seen with the ophthalmoscope.

The retina was intimately connected with the exudation. Another patient, injured in like manner, showed a dark spot in the region of the macula lutea, which had a corresponding scotoma in the field of vision. After extirpation of this eye in consequence of sympathetic affection of the other, there was found a globular exudation, developed from a former extravasation of blood. The ciliary body and iris were not involved.

Prof. O. Becker had observed *twenty-two cases of gun-shot injury of the eye*, none of which were as yet followed by sympathetic trouble of the other eye.

Dr. Woinow spoke of *astigmatism in cases of cataract operation.* He remarked that the same glass was not the correct one in all cases operated upon, after some time had elapsed, and that the astigmatism determined by glasses was different from the astigmatism of the cornea. Sometimes a different cylindrical glass, with the axis turned in a different direction, must be given for the distance from the one necessary for the near-point.

Prof. Donders, of Utrecht, had observed a case of *total absence of the color-perception:* achromatopsia. The patient had some photophobia, and wore colored glasses by preference, but the color was a matter of indifference to him. With dioptrical spectra from petroleum and other species of illumination, he indicated correctly the position of greatest illumination, from which point the light seemed to diminish uniformly towards either side. He saw very little by ordinary illumination. The discs of the optic nerves had a somewhat atrophic appearance.

Donders had made examinations upon two cases of *congenital strabismus*, which militated against the empirical theory (Helmholtz) of a common visual act. If an electrical spark is produced in an absolutely dark room, its position may be correctly indicated with both eyes, almost without an exception, but with one eye only in about half of the experiments. He found that if he corrected the squint exactly by means of prisms, both eyes indicated correctly the position of the spark every time in twenty-two experiments ; if, however, he allowed some deviation to remain uncorrected, they failed in about half of the cases to indicate correctly, in other words the result was like that of a monocular investigation. These experiments seemed to prove that the power of stereoscopic vision is congenital (Hering).

Dr. Wecker had found the *color-perception intact in two cases of microphthalmus*, in which the eyes were not larger than peas, and had no cornea. O. Becker had observed the same.

Dr. Critchett, in the name of his London colleagues, invited the members of the Congress to hold the *international meeting next year in London*, which was accepted, and ordered to be included in the minutes as a resolution.

The meeting was closed by Donders with some remarks upon A. von Graefe. He proposed that a monument should be erected to his memory. The proposal was agreed to by all the members, and the matter given into the hands of a committee.

A TEARSTONE IN THE CANALICULUS LACHRYMALIS INFERIOR.

BY DR. ALEXANDER PAGENSTECHER, OF WIESBADEN.

Translated by Dr. Chas. J. Kipp, of Newark, N. J.

IF an apology is needed for making a single case the subject of this communication, it may be found, I think, in the fact that the case is a rare one. Cases of the formation of stone in the lachrymal apparatus, the lachrymal gland as well as the organ for carrying off the tears, are, on the whole, of rare occurrence. Dacryoliths have been relatively most frequently observed in the ducts of the lachrymal gland. Mackenzie mentions such a case, in which twenty-three small stones were, from time to time, removed from the excretory ducts of the lachrymal gland. Notices of dacryoliths in this gland, in the conjunctival sac, in the caruncula, in the canaliculi, and in the lachrymal duct are also found in Himly. It is not very clear whether those found by Himly in the canaliculus were real stones or whether they were collections of leptothrix fungi, which, as is well known, frequently enclose concrements of chalk. Von Walther also makes mention of stones in the above-named parts of the lachrymal apparatus, with the exception of the canaliculi.

Ruete has found stones in all parts of the lachrymal apparatus, but in the canaliculi he found only chalk-like concretions.

Desmarres alleges to have been the first who extracted a stone from the canaliculus in 1843. Graefe, who published in the first part of the 15th vol. of the Archiv f. Ophthalm. several cases of leptothrix fungi, found in the canaliculus, is of opinion that the above-mentioned case of Desmarres should be regarded as one of leptothrix formation, with an admixture of chalk particles. I have been unable to find a single case of dacryoliths in the canaliculus in the entire literature at my command.

A Mr. C., somewhat over 70 years of age, had never suffered from disease of the eyes; his vision is intact. During the previous summer he had had several attacks of vertigo with impeded speech, which were of short duration, and were probably due to an atheromatous degeneration of his vascular system, but which do not appear to have any connection with his eye trouble.

For several years he has suffered from a very troublesome epiphora of his right eye; he had repeatedly sought the advice of several physicians about it, but had not obtained any permanent relief. Mr. C. consulted me for the first time in the autumn of 1869, the condition of his right eye being as follows: the margins of the lids, the upper as well as the lower, are covered with thick crusts; the hair-follicles and the glands are in a state of inflammation, and an eczematous eruption covers the upper part of the right cheek. The entire conjunctiva bulbi, as

well as the conjunctiva palpebralis, is slightly swelled and hyperæmic; the eye is always bathed in tears. The slightest irritation increases the secretion of tears in an unusual degree. The swelling of the conjunctiva is most markedly developed in the neighborhood of the caruncle and the plica semilunaris. The upper punctum and the margin of the upper lid are, with the exception of the crusts in the latter, in a normal condition. The lower punctum is dilated to two or three times its normal calibre, and is in an outward and downward direction, about 2‴ distant from the caruncle, producing an ectropium of medium degree, which extends to the middle of the lower lid. The lips of the margin of the lower lid are effaced as far as the ectropium extends; the margin being round, most conspicuously so between the punctum and the caruncle. This portion of the margin of the lid, which corresponds to the canaliculus lacrymalis, is elongated to twice its normal length; and in addition to its cylindrical roundness, is also increased in breadth and height in a transverse direction. The whole presented the appearance of a small tumor of the size of a split pea, developed at this point. On palpation the tumor gives the sensation of cartilaginous hardness; and although a turbid liquor escapes from the punctum every time it is touched, the size and form of the tumor remain always the same. Neither dilatation nor blennorrhœa of the lachrymal sac could be discovered.

The affection was so masked by the great catarrhal swelling of the conjunctiva and the eczema of the lids,

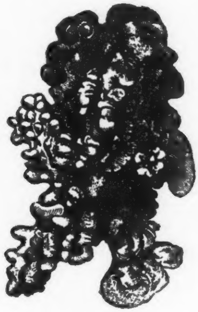
that I could not make a positive diagnosis at the first examination. I therefore recommended at first fomentations with dilute liq. plumb. hydrico-acetici, great cleanliness, and rest for the eyes; being under the impression that I had to deal with a dermoid tumor, I at the same time intimated to the patient that a small operation would probably be necessary.

About two weeks later, when I saw him again, the irritation had considerably subsided, and the eczema had disappeared; but the margin of the lid and the tumor had undergone no change in form or hardness. With a view of informing myself as to the functions of the tear-passages, I wanted to make an injection through the lower punctum with an Anel's syringe; but as soon as I had introduced the point of the syringe to the depth of about a line, I perceived a grating noise, produced by the movement of the syringe. An examination with the probe produced the same sound, and convinced me that a hard body obstructed the passage.

I next opened the canaliculus in its entire length, with a small probe-pointed bistoury which I always use for that purpose, and was now able to extract a small stone with a Daviel's spoon.

This stone (see fig. on next page) presents, on the whole, a cylindrical form, with numerous small and round elevations; it is 6 millimetres in length by about 3 mm. in width; has a dark brownish-gray color, passing over into a lighter gray at the most prominent parts of the small protuberances. With regard to the manner in which

it was embedded in the canaliculus, I must observe that it did not completely extend to the lachrymal sac. It was found, moreover, that the small portion of the canaliculus situated between the end of the stone-bed—which was plainly visible—and the lachrymal sac, had retained its normal calibre. The lachrymal sac was unchanged.



The mucous membrane of the dilated portion of the canaliculus was greatly relaxed, and exhibited numerous depressions corresponding to the protuberances of the stone. No concretions or cheesy deposits were seen in the vicinity of the dacryolith.

The removal of the stone relieved the patient at once of all his annoying symptoms, and there has been no recurrence of the epiphora.

As in my case not one of the symptoms was absent, which, according to v. Graefe, are caused by the presence of leptothrix fungi, the relative hardness of the swelled canaliculus may, perhaps, aid us in the differential diagnosis between leptothrix fungi and a dacryolith.

TATTOOING OF THE CORNEA.

By Dr. L. Von WECKER, of Paris.

(With one Wood-cut.)

Translated by T. R. Pooley, M.D., of New York.

It is an acknowledged fact that foreign substances may be introduced into the tissue of the cornea, and remain there for a long time without producing any irritation. How often we see abnormal coloring of the cornea, caused by the injudicious use of preparations of lead and silver in the treatment of ulcerations of the cornea, and how little has this peculiarity of the cornea been made use of for therapeutical purposes.

That we can introduce small quantities of slightly irritating substances into the cornea without the liability of producing any considerable reaction, was made apparent to me by the following observations: I. I observed that in workmen wounded by the explosion of mines, the grains of powder remained in the cornea without producing any remarkable haziness in the surrounding tissue. II. I have often treated children, who have had steel pens stained with ink stuck into the cornea, without the ink left there producing any appearances of irritation.

My first experiments to avail myself therapeutically of this tolerance of the cornea, were to give a black coloring to disfiguring white opacities of the cornea. Ophthalmic surgeons are often requested to remove such leucomata, which even from a distance make a disagreeable impression on the observer, and how often have the surgeons had to declare their inability to do so. Tattooing of the spots enables us to remove the disfiguring in such a satisfactory way that it requires a very attentive observer to notice a difference in the appearance of the two eyes. I have already given it as contrary to my opinion* that the object is not only to give to these specks a grayish tint, but that the purpose of the treatment is to color the opacities so entirely black, that after the lustre of the cornea has been restored by an even coating of epithelium, such a central colored spot gives to the observer the impression of a black pupil. With some perseverance on the part of the physician and patient such a result may be obtained in from 6–8 sittings, and I have often presented to the visitors at my clinic such patients, who have been operated on to their satisfaction. It seemed to me in the beginning of my experiments, that tattooing of the cornea could only be employed to obtain most satisfactory cosmetic results, when my attention was drawn, through some of my patients, to another use of this little operation.

* See A. v. Reuss, "On Tattooing of the Cornea," Wiener Medizin. Presse, No. 47, 1870, and "Letter to Dr. A. v. Reuss," by L. v. Wecker, Wiener Med. Wochenschrift.

I have often made the operation in central adherent leucomata after having formed an artificial pupil, more fully to restore the visual power. Nearly all patients thus operated upon, in whom the central extreme haziness extended to that part of the cornea which was opposite the artificial pupil, and in whom I made the tattooing upon this grayish part of the cornea, said spontaneously that after the completion of the tattooing, the visual power of the eye operated on had considerably improved.

There is no doubt that the suppression of the diffusion of light plays the part of a stenopæic glass. I decided, therefore, for optical purposes, in central semi-transparent opacities, which are so detrimental to visual acuteness, to make a small pupil downwards and inwards, and then to color entirely black the central grayish part of the cornea. I scarcely need mention, especially in a darkly pigmented iris, that tattooing removes the peculiar dull expression caused by such central specks. The number of cases treated by me, in this way, is yet very limited, but the results obtained appear to me highly satisfactory, and I think we may find in this operation, in certain cases, a substitute for the stenopæic glass, which patients dislike so much to wear.

As regards the method itself, I make use of a small chisel-shaped knife, such as is used in England for re-

moving foreign bodies from the cornea. The knife must be ground to a fine point like a needle, and the groove is to be filled with concentrated indian-ink. I put in the speculum, fix the globe, and have always in readiness two such knives, in order to execute quickly the 10–20 punctures under the epithelium. These punctures must be made very close to each other; and when the opacity is thickly sprinkled with punctures, then I color very carefully the interstices at the following sittings. I have never noticed any violent appearances of irritation following the little operation, and most of the patients resume their business immediately. To obtain the most satisfactory results in extensive leucomata, we must have from 6–8 sittings. We never find any resistance on the part of the patient, the operation being so painless that they are not disturbed in their business. Softness of the cicatricial tissue facilitates the imbibition of the coloring matter; but old hard cicatrices, especially those mixed with chalky material, make the operation more difficult, and require more frequent repetitions.

I do not doubt for a moment that tattooing of the cornea will find a definite place in the treatment of eye diseases, on account of the painlessness of the method, the absence of any danger, and the ease of its execution.

Even the fear expressed by some patients that the results of this operation may disappear in some years, is easily overcome, on account of the want of pain, and the little time required for a repetition of the procedure.

THE GALVANIC TREATMENT OF DISEASES OF THE EYE AND EAR.

By Prof. W. ERB, M.D., of Heidelberg.
Translated by X. C. Scott, M.D.

Although the treatment of diseases of the organs of the higher senses by means of the galvanic current is not new, yet it has only lately acquired a rational foundation by scientific research. The different attempts, from the time when the old galvanists tried to cure cataract and deafness by the magic power of the Voltaic pile, down to the endeavors of *Duchesne*, partially crowned with success, to remove hereditary deafness by the secondary current, were almost entirely unavailable, and did not find acceptance in practice. Only to the endeavors of modern electro-therapeutists are we indebted for more accurate knowledge of the mode of operation of electricity in the different diseases of the eye and ear. Thorough investigations upon healthy and diseased subjects have given the necessary basis for the foundation of a rational mode of treatment.

In regard to the diseases of the eye, we find in Remak's writings only very cautious remarks on the results of galvanic treatment of nervous diseases of the eye; Duchesne,

likewise, although discussing thoroughly the paralytic affections of the muscles of the eye, makes only very aphoristic notes on the electric treatment of certain forms of weakness of sight; the other writers on electro-therapeutics speak exclusively of the paralysis of the ocular muscles, which they dispose of in a few words. It is an essential merit of Benedict's to have brought the nervous diseases of the eye, in a comprehensive manner, into the reach of galvanic treatment, having first written an article on paralysis of the muscles of the eye in the Archives of Ophthalmology, X., 1, 1864, p. 97, and secondly, having published in his book on electro-therapeutics, observations on the galvanic treatment of the diseases of the optic nerve (atrophy and neuro-retinitis), which appear in a great degree favorable to excite the attention of ophthalmologists. The results of Benedict's observations are in the greater part new and surprising, and seem to open a new and important field to galvanism. According to my knowledge other investigators have not yet made or published similar observations on an extensive scale, although these would be very desirable in the interest of the subject. Up to the present time I have had frequent opportunity to make observations only in paralysis of the ocular muscles; the results of which I desire to communicate briefly, because this subject is relatively new, and remains dark and unexplained in many respects.

The galvano-therapeutics of the diseases of the ear, especially in the so-called nervous deafness, has entered upon a new era, principally through Brenner's excellent

researches (see particularly his principal work, "Researches and Observations on Electro-therapeutics," Vol. I.). The foundations of electro-otiatrics laid down by Brenner have been confirmed by different observers in every essential point; but, nevertheless, authors of good repute have tried to prove them false. Lately Benedict (Vienna Medical Press, 1870, Nos. 37, 39, 42, 43, 47, 48, 50, 51, and 52) has appeared as the most important opponent to Brenner's assertions. He rejects the "Polar" method founded by Brenner, and likewise violently attacks the foundation of his electro-otiatrics.*

* Professor Benedict has complained on account of an essay upon the law of the convulsions of the motory nerves in the Vienna Medical Press, No. 32, 1870, that I had, both in the German Archives of Clinical Medicine and in Canstatt's Annual Report, indorsed the researches of *Brenner* and his criticism of Benedict's Book. If Professor Benedict thinks that the criticism printed in the German Archives has, from technical reasons, gone into the Annual Report unchanged, he is mistaken, since this is simply not true, as my honored colleague could easily have convinced himself by comparing the two articles. In the German Archives there is only a brief report, but in Canstatt's Report an extensive extract of Brenner's book, to which indeed some criticism is attached, according to the plan of the Annual Report. To give an opinion as a reviewer, even the friendly "*apostrophe*" addressed to the editor of the Annual Report, shall not restrain me. That my opinion of Brenner's book appears in both periodicals invariably the same, is not the result of technical reason, but of the simple fact, that my conviction of the excellencies of this book has remained unchanged. Besides, if Mr. Benedict thinks that I desire through these discussions to inaugurate a "clique-policy," I must protest decidedly against such an insinuation. If I have indorsed the views of Brenner it is because I have been convinced of their correctness and good foundations from my own numerous and detailed observations. I shall acknowledge Benedict's assertions with the same readiness, as soon as I am able to confirm them with certainty from my own experience. At all events, I believe that I am able to await with an undisturbed mind, the "bitter hours of disappointment" which my honorable Vienna colleague predicted to me.

This polemic is apparently based on facts which *Benedict* asserts he has observed, and which are, in many points, diametrically opposed to the positive and decided statements of *Brenner* and others. On this account I have believed it my duty, for the purpose of maintaining the truth, to repeat my convictions founded upon numerous experiments and observations, and to support them by facts. It is time that we should finally be united upon questions of so great importance, and especially the facts should be determined under every condition; the explanation of which has certainly to be left to the acuteness and disposition of each investigator.

These considerations have induced me to communicate the following remarks, which in themselves do not offer many new facts, but will serve as a confirmation of previous assertions and a defence against superficially and badly founded objections. They are some observations on paralysis of the ocular muscles and affections of the auditory nerve, which I now publish together, because a part of them occurred in the same individuals. I thought it more imperative not to keep back this communication, since the majority of physicians engaged in this branch of science do not seem to study these questions sufficiently.

I shall first briefly relate my experience in paralysis of the muscles of the eye. Through the kindness of my friendly colleagues, Profs. Knapp and O. Becker, I had the opportunity to examine and treat a series of such cases. By far the greater number of these cases were

peripheric, the so-called rheumatic paralysis probably preponderating; and they were in most cases regularly treated, while in paralysis of the ocular muscles caused by cerebral disorders, frequently the poor success of the previous therapeutic attempts caused them soon to desist from the galvanic treatment.

The method of treatment started here as everywhere from the principle, to apply the galvanic current as directly as possible to the seat of the disease. Our ignorance of the real seat of disease, in cases of rheumatic paralysis of the muscles of the eye, really places some serious obstacles in the way of this intention. In every case, it is certainly questionable whether the disease is located within the orbit or the cranial cavity. In order to meet both of these possibilities, I apply the electrodes to different parts of the skull and begin with the stable arrangement transversely through the skull—through the temples as well as through the mastoid processes. Following a tradition of Remak, according to which the stable current, and particularly the anode, is effective against "rheumatic" affections of the nerves, I generally apply the arc to the affected side; but many times it appeared to be advantageous afterwards to apply also the current in an inverse direction. No one will demand the exact reason for this, who is acquainted with our ignorance of "rheumatic" affections of nerves and muscles, and the defective foundation of the catalytic action of the galvanic current. The strength of the current is so chosen, that a faint sensation of the skin or a

slight attack of dizziness is produced. Stronger action upon the brain is to be avoided; 6–8 Stœhrer's elements are generally sufficient. The duration of the application at each place is from ½ to 1½ minutes.

With this application I generally combine, according to the advice of *Benedict*, the galvanization of the sympathetic in such a manner, that the broad disciform anode is applied to the region of the upper cervical ganglion, while the cathode is placed on the nape of the neck.

It is not exactly clear to me what effect this application, so often recommended by *Remak*, has upon paralysis of the ocular muscles. I have never yet been able to determine any effect which could be traced back with certainty to this method. Yet the strong indorsements which it has received, has made me unwilling to neglect it in the interest of the patient.

I believe the most advantageous method of application to be the direct excitement of the paralyzed muscle by the cathode. The an. is placed on the back of the neck, while I at the same time move the ca. back and forth for some minutes over the closed eyelids and parts corresponding to the lamed muscles. I do not determine the necessary force of the current from the more or less sensibility of the trigeminus; but from the contraction of the facial muscles, after irritation of corresponding branches of the *nervus facialis* by the ca. I generally choose a sufficient strength of current to produce distinct muscular contractions upon irritation of the frontal

branch of the facialis; at the same time there exists a distinct burning sensation upon the eyelids, which is only with very sensitive persons so unpleasant that it becomes necessary to diminish the force of the current.

I select the above-mentioned arrangement for the electrodes, because I think that in this manner the paralyzed nerve and muscle is most certainly reached by efficient loops of the current. It is well known that direct irritation of the ocular muscles with certainty by means of the faradaic or galvanic currents, is either impossible or very difficult, and therefore we are unable to ascertain any eventual changes of their electric irritability in cases of paralysis. At all events, it seems to result from all previous experience, that recovery from paralysis of the muscles of the eye may occur under the influence of the induced current, which is insufficient to excite contractions in the same muscles. Benedict believes that generally the treatment by direct excitation of the paralyzed parts is not even necessary, but that the therapeutical results are brought about by a reflex irritation of the trigeminus. I cannot support this hypothesis, because it does not appear to be sufficiently founded. Contractions of the outer muscles of the eye upon cutaneous irritation of the face are, as far as my knowledge goes, not to be determined under physiological conditions, consequently we must not rationally expect them under pathological conditions. It is even less to be expected as the interruption of the centrifugal course of conduction has first to be removed by means of the

electric treatment; since on the other hand we cannot, even with the unfavorable mode of application of the electrodes, selected by *Benedict*, prevent loops of the direct current reaching the muscles and nerves; I do not see why, especially in cases of paralysis of the ocular muscles, we should select the reflex circuit for the explanation of the curative result. I am not inclined to make poor trigeminus responsible for every imaginable phenomenon of irritation of parts of the head.*

* To what extent of error many authors may be led by this disposition, a recent publication by Dr. Althaus, of London, teaches. This observer (*German Archiv. for Clin. Med.* V. II. p. 563) concludes from one case of anæsthesia of the trigeminus, in which the cerebral phenomena during galvanization of the head were very insignificant, that these phenomena of galvanic irritation (dizziness, nausea, etc.) would occur also in the course of the trigeminus. The report of the case does not justify this conclusion. The observer has omitted to make the simple test to prove that after the recovery from the anæsthesia, the cerebral symptoms during galvanizing occur with the ordinary intensity. Moreover, he has given no proof that the cerebral phenomena were as easily produced as usual, from the parts behind the ear not affected by anæsthesia. His conclusion would finally necessitate the acceptation that also galvanic sensations of light, taste, and smell are produced through the trigeminus, since these were also very feeble in this patient. Notwithstanding this remarkably superficial observation, the author is proud to have decided this important question with the history of his case. On the other hand, I must always concede the possibility, that by this method a favorable influence upon the paralyzed ocular muscles is to be obtained. Therefore, I apply the electrodes in such a manner that it must be successful, if the effect depends either upon direct or reflex excitation of the trigeminus. Although Benedict advises to apply the anode upon the forehead and to move the ca. over the skin around the eye, it is evident that this must be an exceedingly unfavorable arrangement for a direct current through the muscles, while the application of an. to the nape of the neck satisfies every demand in this regard, at the same time the ca. is moved back and forth over those parts

The future must teach us whether the fact discovered by Hitzig (*Berlin Clinical Weekly*, No. 11, 1870), that movements of the eye are caused by galvanization of the region behind the ear, will be of any value in the treatment of paralysis of the ocular muscles. I have not investigated this question.

I must confess, in regard to the curative results obtained by me, that I was unable to deduce any certain facts in support of the curability of the different cases. Apparently quite identical rheumatic peripheric paralysis in different individuals requires a very different length of time for its cure. I cannot even state that very recent cases coming under treatment promise an absolutely favorable prognosis, since such cases now and then require a very long time for their cure (for example, Cases 1, 2 and 3); here, certainly, a similar condition exists, as in rheumatic facial paralysis. On the other hand I am able to state, that *in almost every case a momentary improvement is present immediately after the treatment:* the double images move nearer to each other, the excursions of the eye become greater. In unfavorable cases this entirely disappears again; but in favorable cases the improvement remains constant and can be advanced from day to day. I am also able to confirm from my own observations the statement of *Benedict*, that in cases in which the absolute latitude of the excursion increases more rapidly than the approach of the double images,

designated by *Benedict* as the most favorable for reflex irritation. The immediate improvement in many patients seemed to me to be greater by this mode of applying the electrodes.

the prognosis in regard to the duration of the disease is not especially favorable; such cases require a very long time for a cure (Case No. 3 is a good example).

I have found paralysis of the *abducens* the most frequent among the single forms of paralysis; they also offer the most favorable prognosis, although they require a very different length of time for their cure. The rheumatic paralysis of the abducens seems in every case to be curable; on the contrary, I was unsuccessful in several cases of central origin.

Two cases of paralysis of the oculo-motorius, which I treated, were quickly cured. I have also seen a favorable result in two cases of paralysis of the trochlearis. I have always found cases of mydriasis, with or without simultaneous paralysis of accommodation, to be very obstinate. Generally an amelioration was soon effected, but a complete cure only very slowly, after months of treatment, or not at all.

In the following I shall briefly report several observations, since several of them offer interesting anomalies of the auditory nerve. I shall also add some other cases of affections of the ear, which I treated. At the same time I shall embrace the opportunity of giving my opinion in detail upon the now pending electro-otiatric controversy.

CASE I.—*Rheumatic paralysis of the abducens.* John Volz, æt. 27, sent to me by Prof. Knapp on the 12th of March, 1867, was suddenly affected on March 6th with double sight, in consequence of a cold. At

first he suffered somewhat from headache. At present there is a complete paralysis of the right *rectus externus*, without any other anomaly. Every other movement of the eye is normal. Galvanic treatment with 12 El. Stœhr. an. on the nape of the neck, and ca. labile along the right temple and outer parts of the eyelids. With this arrangement patient has a slight burning sensation. *Immediately afterwards he moves the eye a little more outward* than before the treatment. Under this daily treatment the power of excursion of the eye evidently increases. Simultaneously the double images approach each other. This is especially evident after each session. After fourteen sessions the patient is discharged, on the 28th of March, cured.

CASE II.—*Rheumatic paralysis of the abducens.* Franz J. Karst, æt. 34, railroad engineer, sent by Prof. Becker, suffers from double vision for ten days, probably the result of a cold. There is a paralysis of the right abducens muscle; the eye cannot be moved outward beyond the median line. Treatment, 8 El. Stœh. transversely through the temples, sympathetic in neck, and ca. lab. along the region of the *rectus externus*, at the same time the arc is on the left side of the neck. Immediately afterwards patient can move the eye a little more outward. After the fourth session, double images much nearer together, and eye can be turned almost to the outer canthus. After ten daily sessions, discharged cured.

CASE III.—*Rheumatic paralysis of the abducens.* Mr. E., about forty years old, hotel proprietor, came under treatment August 22d, 1870, from Prof. Becker; suffers for two days from double images, in consequence of a cold. At the first examination only a paresis of the *rectus externus sinister*; double images begin only at some distance to the left of the median line. No other muscle of the eye is affected; all the other cranial nerves free. General health is good. The galvanic treatment was carried out in the usual manner.

August 25th. A complete paralysis is present: the eye can no longer be turned outward beyond the median line. With the object at 1′ distance, the double images begin already about ½′ from the median

line. September 2d.—From the twelve previous sessions no essential improvement has been accomplished. Iodide of potassium prescribed, and the galvanic treatment omitted until September 12th. At this date a slight improvement is evident, and the galvanic treatment commenced again. There is an apparent improvement of motility now after each session, but soon it almost disappears again. September 20th, evident improvement; the eye moves further towards the external commissure. To-day, before the session, double images commence $2\frac{1}{2}''$ to the right of the median line; after the session, about $1''$ to the right. The vision is considerably improved. October 20th.—Improvement especially evident in the absolute power of excursion; the eye can be turned almost to the external angle, but double images still begin to appear to the right of the median line. November 15th.—Absolute excursion is now normal; eye turns to outer canthus; double images commence now at $2''$ to the left of the middle line. The cure could only be considered as completed towards the end of December, after about fifty sessions.

CASE IV.—*Paralysis of the right oculo-motorius—Paralysis agitans of left arm.* Abraham Klein, æt. 70, sent by Prof. Knapp April 1st, 1867, suffers for one year from trembling of the left arm. Already two months ago he observed, now and then, double images, but they disappeared again. On March 20th a nearly sudden complete paralysis of the right upper eyelid appeared, so that the eye remained closed from that time; pain in the depth of the orbit and right half of forehead was connected with it. The examination shows that there is a complete paralysis of all the ocular muscles supplied by the oculomotorius dexter. The abducens and trochlearis are free; the other cerebral nerves show no anomalies. In the extremities there is no anomaly besides the trembling of the left arm. Treatment, 12 El. ca. labile, an. behind the left ear. April 12th.—Evident improvement, the eyelid can be raised enough to leave the pupil free. The movements of the bulb itself are not yet essentially improved. The motility returns only slowly and gradually in the several muscles; nevertheless

the patient can be discharged, May 24th, after twenty-eight sessions, as cured.

Case V.—*Paralysis of the trochlearis dexter and insufficiency of the rectus internus—Pterygium.* Joseph Meiner, 52 years old, from the Eye Clinic of Prof. Becker, suffers for about a fortnight, probably the effects of a traumatic lesion, from symptoms of a paresis of the *obliquus sup. dexter*, combined with insufficiency of the *rectus internus.* At the same time there is a pterygium of the same eye. Treatment is commenced on the 19th of October, 1870, in the usual manner. The momentary success is very remarkable with this patient, since the diplopia disappears immediately after the session. This occurs at every session. November 1st.—The insufficiency of the *rectus internus* is entirely removed. Patient takes iodide of potassium. From November 3d to 8th the galvanic treatment is omitted on account of the pterygium operation. November 8th.—The diplopia has somewhat increased, but it disappears immediately after treatment. November 15th.—Patient may be considered as cured; he is able to work without any difficulty at his trade as a locksmith. To-day he is discharged from treatment, after the twenty-third session.

Case VI.—*Paresis of musc. obliqui super. et recti intern. dextr. Hyperæsthesia of right auditory nerve.*—Andrew Rische, æt. 54, laborer, from Prof. Becker's Clinic, entered upon treatment November 26, 1869. He has suffered from partial deafness since his youth; when a child, had otorrhœa; but lately the *deafness* has increased. The patient has always had, so long as he can remember, roaring noises in his ears, sometimes like boiling water, many times like a noisy roar. The noise is located in the ears, and has about an equal intensity in both ears.

Four weeks ago patient fell down stairs on his face, which is slightly excoriated. He was not unconscious, nevertheless the eyelids swelled greatly, and the patient observed on the following day the still existing disturbance of sight; diplopia especially in certain directions of vision. The ophthalmic investigation shows the following complicated

condition: paralysis of the right trochlearis muscle, with simultaneous insufficiency of the *rectus internus* and (probably secondary) contraction of the *obliquus inferior*. Vision good, eye clear, hearing bad. On either side a watch is not heard on contact, and even no better through conduction of the bones. Understands speaking tolerably well on the left side, even whispering is understood at one foot, but on the right side he only understands a very loud voice. The right tympanic membrane is not visible; in its stead, a white, shining mass, in front of which a sinewy string extends transversely across the auditory canal. The inner end of the canal is very red. The drum-head of the left ear is thickened and opaque; the region of the handle of the hammer protrudes as a whitish, swollen eminence.

The Galvanic Examination of the Ears.—(External arrangement of experiment, without water in the auditory canal, electrode B on the back of the left hand.*)

Right Ear: We find immediately the *pronounced formula of simple hyperæsthesia of the acoustic nerve.*

6–10 El. Stoehr. Ca C H′, loud hissing, as from a steam-engine.
Ca D H∞
Ca O —
An C —
An D —
An O h′ > the same, gradually disappearing.

A distinct hissing appears upon Ca with 4 elem. and even 2 El., with Voltaic Alternatives.

With An C and An D patient discloses, with the strongest force of current; "All is quiet."

It is evident, in regard to the roaring noise, that it is weaker with An D and with 12 El. Stoehr. it vanishes entirely in the right ear, while it still remains the same in the left.

* For an explanation of these characters and formulas refer to the author's essay, "On the Galvanic Reaction of the Nervous Apparatus of the Ear," in the Archives of Ophthalmology and Otology, by *Knapp* and *Moos*, Vol. I., Part I., pp. 232, etc.

Left Ear: Even with 14 el. no sensation of sound is produced in this ear. Same result with Volt. Alt. The sensitiveness of the patient prevented the application of a stronger current. On the other hand, there appeared with 10–14 el., if the left ear was armed, the so-called *paradoxical reaction of the right ear* in the following way:

Left ear armed.	Right ear not armed.
12 El. Ca C —	—
Ca D —	—
Ca O —	h (hissing)
An C —	H ′
An D —	H∞
An O —	—

This is the ordinary form of "paradoxical reaction." I have no notes about the condition of the roaring noises with the left ear armed.

The patient was treated only on account of his ocular paralysis, since the continuation of the affection of his ears was of no consequence to him, "because it did not prevent him from working." He was treated almost daily, according to the above-mentioned method, until the 1st of January, 1870. The diplopia had up to the present time somewhat improved, so that the patient could work well again. Afterwards he came very irregularly, once or twice a week, for treatment, and from March 15, when a considerable improvement could be confirmed, he gave up treatment entirely.

CASE 7.—*Paresis of right external rectus muscle.—Hyperæsthesia of both acoustic nerves.*—Philip Fehringer, æt. 59, Shoemaker (from clinic of Prof. Becker); entered upon treatment January 7th, 1870. Formerly always in good health; two years ago had a transient difficulty of hearing. Since six months the hearing has again become bad without any particular cause; also for the same length of time there have been noises in the ears, about the same upon either side; "ringing" or "seething of boiling water." This continues day and night. No headache; but since 4 weeks increasing dizziness; head dull and as if

it was constricted. For about 3 weeks there has been diplopia, especially when looking to the right side.

Stat. præs. Patient looks somewhat decrepit. Paresis of the right *rectus internus;* double images already from the median line. The examination of the ears kindly made by Prof. Moos gave the following results: chronic catarrh of the midde ear. Dulness of both membranæ tympanorum, with obliteration of the light spot, peripheric sharp bending of the membrane, particularly of the right. Both Eustachian tubes are pervious; conduction of the bones feeble for a watch of 30′ H. O., but better on the right than left. Tuning-fork upon the head not heard on the left side. The same watch right 8″, left 5″; after catherization, roaring noises stop, right 12″, left 9″ H. W.

The following are the results of the galvanic examination.

Left Ear: External arrangement of the experiment, no water in auditory canal, B on right hand.

12–20 El. Pinkus Ca C R′, sounding as from boiling water, with
Ca D R ∞ greater strength of current clear
Ca O— hissing.
An C—
An D—
An O R>

With 10–12 El. there appears with *Volt. Altern.* upon Ca still a clear "clang" sensation. Secondary symptoms developed in a moderate degree.

Right Ear: The same arrangement of the experiment.

18–24 El. Pinkus Ca C R′ Ringing or loud hissing, similar to
Ca D R left ear.
Ca O—
An C—
An D—
An O R>

With 16 and 14 El. still Ca C. R′ with Volt. Altern.

There is a simple hyperæsthesia of the auditory nerve upon both sides, left in a somewhat higher degree than right.

No other anomaly; other cranial nerves normal. General health tolerably good.

The treatment is so arranged, that a stable current is passed transversely through the temples and region in front of the ear; then Ca labile through the region of the *rectus externus. Immediately afterwards considerable improvement;* the diplopia appears only at some distance outward from the median line. Afterwards An D is applied to both ears, with a gradual diminution of current. *Immediately the roaring noises totally disappear*, patient feels quite free and easy in his head, his dizziness has also vanished.

January 8th. The improvement of the paralysis has again disappeared. The noises in the ears are feebler, head much easier and freer. Second course of treatment: instantly afterwards evident improvement of the paralysis and disappearance of the noises.

At first it continued so; patient declared that the improvement remained the entire day, yet on the following morning the symptoms are again very pronounced.

January 20th. The paresis of the abducens has decidedly improved. Repeated experiments show that the momentary improvement does not appear, if the stable galvanic current is passed transversely through the temples, but only, if Ca lab. is applied direct upon the eye. The noise in the ear has decidedly diminished and appears now only transiently. To-day is the tenth of the treatment.

January 31st. Double images almost gone. Very little noise in the ears. Patient complains principally of some remaining dizziness. 19th session.

February 7th. No further improvement, with the conduction of the current transversely through the temples noises appear in the ear, upon which Ca is applied; after Ca O it disappears for some moments. With An D and afterwards gradually diminishing the current the noises entirely cease.

Such was the condition with little variation until the end of March, 1870, when he had had 44 sessions. March 31st patient was discharged from treatment in the following condition: the diplopia has almost disappeared; it troubles him neither in walking nor in working; the double images appear only far to the right of the middle line. The roaring noises have nearly vanished; it appears now and then transiently and in a moderate degree in the left ear. The hearing has slightly improved. The galvanic examination gives the following results.

Right ear: First sensation with ascending Ca C with 14 El. Stoehr. (about = 22 Pinkus), with from 14–16 El. Stoehr. we can construct the formula previously obtained, without the pronounced characteristics of hyperæsthesia. Volt. Alt. produce Ca C Rl only with 10 El. Stoehr.

Left ear: First sensation with ascending Ca C with 10 El. Stoehr. The full formula for simple hyperæsthesia with 10–12 El. (= 18–20 Pinkus). Volt. Alt. give with 6 El. St. still Ca C-Sensation.

There still exists in the left ear a moderate degree of hyperæsthesia; the condition in the right ear is no longer to be designated as hyperæsthesia.

CASE 8.—*Encephalopathy.—Hyperæsthesia of both acoustic nerves.—Rheumatic paralysis of the left facial nerve.*—Victoria Dickgiesser, æt. 29, Servant (from the medical clinic of Prof. Friedreich). I will only mention the most important facts of the history of her disease. Patient in 1862 had a very severe attack of typhus, from which she only slowly recovered; since that time she has suffered often from anemia. Last summer she had an affection of the eye, which was diagnosed as a "gummy iridochoroiditis"; yet the patient has never had syphilis.

About three weeks ago noises commenced in the left ear, similar to the rush of a current of water; simultaneously with it the hearing became somewhat defective. Since a fortnight there has been transient vertigo, often so severe that patient could walk only with great staggering; there is also severe pain in both temples. December 20.—The

left half of the face somewhat swollen; but this passed off two days afterwards and left remaining a paralysis of the left half of the face.

December 23d. Patient was examined for the first time; a nearly complete paralysis of the left facial nerve exists, only the eyelashes moved a little; the reflex action of the conjunctiva very much diminished. Faradaic and galvanic excitability perfectly normal.

December 29th. The facial paralysis has already evidently improved, patient can close his eye and slightly wrinkle his forehead. The other symptoms, particularly the roaring noises in the ears, remain unchanged. To-day a more accurate examination of the ears gives the following results.

Right ear: Hearing-distance for a watch$=2'$; conduction of the bones present. The drumhead somewhat dull, light spot scarcely seen, short process of the hammer very prominent, the part of the membrane lying in front of the handle drawn inwards. The galvanic examination shows a pronounced *simple hyperæsthesia* of the right auditory nerve (external arrangement of experiment, B. upon the left hand). With 12–20 El. Pinkus ($=$ 8–12 Stoehr.) the formula for simple hyperæsthesia appears in an exquisite manner. The accompanying sound sensation is compared to the buzzing of a fly, and with a stronger current it becomes clearer and more intense. With 10 and 8 El. Pink., a sensation appears only when turning to Ca. An C is always without sensation. The roaring noises do not exist in this ear.

Left ear: hears watch only on contact, conduction of the bones on this side very feeble, only existing from the temples. The membrane of the tympanum more opaque than on the right side, light spot entirely wanting. There is in this ear a constant noise like the roaring of water.

In this ear the hyperæsthesia manifests itself during the galvanic examination thus: that with Ca C and An O the noise is much louder and more intense, and more like to the noise of boiling water, while it is feebler with Ca O and An C; with An D with stronger current it vanishes entirely. With 22 El. Pinkus it vanishes, but it returns in a

feeble degree after slow diminution of the strength of the current through the battery (without rheostat).

The treatment, which is only undergone once in several days, consists in the application of An D to the left ear with subsequent diminution of the current. Besides, patient takes iodide of potassium internally on account of his cerebral symptoms.

January 14th, 1870. The facial paralysis is now perfectly healed. The roaring noise in the ear has considerably diminished and frequently intermits for a long time. The objective condition of the ears is still the same as at the first examination. The subjective noises in left ear disappear with Ca O now entirely, and still more certainly and easily with An D. With to-day's treatment patient is discharged quite free from noises, after having carefully diminished the current.

February 3d. The roaring in ears has almost disappeared, only a trace to be perceived. The hearing-distance for watch has increased to 10″ in the left ear, and after the galvanizing it is even 12″. Conduction of the bones is now also present from the mastoid processes. The noises in the ear again removed by An D.

February 9th. The noise in the left ear has completely disappeared for several days, the hearing-distance increased to 12″. On the other hand, noises have appeared in the right ear, which likewise vanish easily through An D with subsequent careful diminution of the force of current.

February 24th. No return of noise in the left ear. Hearing-distance 18″; conduction of the bones much improved. Slight noise in the right ear. From this time only the right ear is treated.

March 10th. Left, no longer a trace of noise; right, still a very little. Vertigo has almost entirely passed off; patient walks much more securely.

March 27th. To-day once more an accurate examination; *the left ear has been permanently free from noise for several weeks; in the right there is scarcely a trace remaining.* Left, hearing-distance $= 18''$, right, $= 2\frac{1}{2}'$. Dizziness has entirely passed away; walking much firmer. There is no longer a trace of the former facial paralysis.

The galvanic examination gives the following results:

Right ear: With ascending Ca C the first sensation appears with 10 El. Stoehr.; afterwards with 8–14 El. St. the full formula for simple hyperæsthesia is clearly produced with loud sound-sensation. With 6 El. Volt. Alt. still the Ca C-sensation (boiling water).

Left ear: First Ca C-sensation with 10 El. Stoehr. We can produce clearly the full formula for simple hyperæsthesia only with upwards of 12 El. St. An O is difficult to obtain, clang sensation similar to that on the right side but feebler. Descending, a weak Ca C-sensation is to be obtained still with 6 El. Volt. Alt. To-day the statements of the patient are, as always, unusually precise and certain.

To-day ends the treatment.

Three months later—June 29th, 1870. I examined the patient again; she has been well the entire time. The head is entirely free. There is no longer dizziness or anything like it; she walks well. The roaring noise has quite disappeared in the right ear, and appears in the left ear only now and then for about a half-hour in a feeble degree. On the right side the hearing-distance has increased to $4\frac{1}{2}'$; left, it remains at $18''$.

The galvanic examination shows very distinct improvement in various directions.

Right ear: With ascending Ca C the first sensation of sound (boiling water) appears with 16–18 El. St., and the full formula only after repeated trials with 18–20 El. An C always without sensation of sound. With this strength of current the "paradoxical reaction" appears in the ordinary and regular manner in the left ear. The degree of hyperæsthesia in the right ear is not worth mentioning.

Left ear: First Ca C-sensation appears with 12–14 El. Stoehr. The full formula for simple hyperæsthesia with 12–20 El. With 10 El. Volt. Alt. still Ca C-sensation. In this ear with all degrees of current with An C and An D, "all is still." A moderate degree of hyperæsthesia still exists in this ear, and it is interesting to confirm, that simultaneously a moderate degree of roaring noise in the ear, and a

distinct diminution of hearing exists, while in the right ear there is nearly normal acuteness of hearing and freedom from noises. The galvanic reaction of the acoustic nerve has also become normal again.

CASE 9.—*Tabes dorsalis.—Double iritis and neuro-retinitis.—Hyperæsthesia of the left auditory nerve.—Noises in the ears.—Inversion of the formula in the right ear with a slight degree of hyperæsthesia.*—Joseph Schneider, æt. 36, farmer, from Odenheim, was sent to me by Prof. Becker, whom the patient had first consulted on account of the disease of his eyes. From the exceedingly interesting history of the case only the most important facts are briefly related.

Patient was formerly perfectly healthy. The present disease commenced in December, 1869, with frequent chills, *debility* of the extremities and *headache.* Increasing *weakness of legs, dizziness,* and often marked staggering. At the commencement of February, 1870, noises in the head began, at first upon both sides, later confined to the left. Since the beginning of March *affection of the eyes;* pain and injection of the eyes, decrease of sight. Shortly afterwards *severe trembling of the legs,* especially while standing. Evenings, burning sensation in the soles of the feet, yet no furred sensation, only seldom formication. Diminution of hearing. The other cranial nerves as well as the psychical functions normal. No trouble in urinating or defecating. Sleeps quite well.

Stat. præs. March 31st, 1870; stout built man. When he stands we are immediately impressed with the uncertainty of his legs and the lively trembling of the muscles of the same. In walking, patient puts his feet widely apart, and makes a slight swinging motion with them. If the feet are close together, the patient is still less firm; immediately after closing the eyes staggers badly. To walk in the dark is very difficult. The single movements of the legs are made forcibly and easily. The muscular sensation seems to be intact and also the sensibility of the lower extremities shows no anomaly. Motility and sensibility of the arms quite normal. Facialis and trigeminus without anomaly. The tongue, when put out, deviates slightly to the left.

Uvula straight, and normal motility of the *velum palatinum*. Sexual functions not materially altered. Electric excitability of the nerves of the lower extremities without any remarkable change.

The eyes are affected with chronic iritis and neuro-retinitis. Hearing diminished; right for a watch 3′, left ½″. Conduction of the bones for the same watch present on the right, wanting on the left.

The more accurate examination of the ears, made by Prof. Moos, shows: "double-sided catarrh of the middle ear, total dulness of both membranes, a drawing inward of both handles of the hammers, increased concavity of both membranes, absence of the light spot on both sides. Tuning-fork heard from left parietal bone. Right ear hears watch of 30′, hearing distance at 24″, left ear only at 5″. Conduction of the bones on both sides." Patient has in the left ear besides the continual sound of "boiling water," a sensation of fine buzzing, as from gnats, which he locates in the upper anterior portion of the external ear.

The galvanic examination of the ear (external arrangement of the experiment, without water in the external auditory canal; B upon the hand) shows on March 31st, the reaction of a moderate degree of *simple hyperæsthesia* in the left ear:

8–16 El. Stoehr. Ca C R′, high whistling or buzzing.
Ca D R∞
Ca O—
An C— Secondary symptoms present in the regular manner.
An D—
An O R′>

With 6 and 4 El. still Ca C-sensation with Volt. Alt.

The noises in the left ear first disappear after the long application of An D with 18–20 Elem., and then only the sound of "boiling water," the "buzzing of gnats," remains unchanged. After careful diminution of the current the first sound does not return.

In the right ear no distinct sensation is obtained, not even with 16 El.

The galvanic treatment is directed especially against the existing

spinal affection and to the head. The left ear is treated with An D 20 El. and subsequent diminution of the current.

The result of the treatment was in every direction more favorable than expected. April 8th, after the seventh session it is stated, that the head is freer, the dizziness has decreased; the trembling of the legs has almost ceased. The legs have become stronger. The sensation of "boiling water" disappears after the treatment for hours, and sometimes until evening; the "buzzing of gnats" continues.

April 29th. Continued improvement. The noise is very trifling, and only transiently present. Head more free, walking much easier; patient goes now in the dark much more securely than formerly. Twenty-second session. In May there was a pause of fourteen days in the treatment on account of double iridectomies being made. During this time the improvement remained stationary.

May 28th. Progressive improvement. The walking is tolerably good, also in the dark; standing with closed eyes is now possible without any considerable tottering. Very slight noises in the left ear, head free. The hyperæsthesia of the left ear continues as formerly; whereas the hearing distance has increased to 5′ on the left; conduction of the bones not yet present. Lately patient thinks that he hears less with the right ear, yet he hears watch at 4′. The galvanic examination shows in this ear a very distinct *reversion of the formula for simple hyperæsthesia.* (Mode of experiment as above.)

8–14 El. Stoehr. Ca C—
Ca D—
Ca O Si′>
An C Si′ high whistling or singing.
An D Si
An O—

Secondary symptoms in the usual manner.

With 6 El. Volt. Alt. Still An C-reaction.

To-day, the 33d session. The attempt to produce Ca C-sensation, with the proper manipulations, fails.

June 25th. Progress in the improvement of the motility of the lower extremities. Noises in the ear very small. To-day the galvanic examination of the ears gives without doubt the following conditions:

Left ear: a moderate degree of simple hyperæsthesia as hitherto.

Right ear: moderate degree of hyperæsthesia, with the reverse of formula, as given above. With a strong force of current: 16–20 El., the left, unarmed ear, which has been exalted in its excitability through the previous examination, begins at once to react according to the "paradoxical formula." On account of the reversion of the formula on the right side, the sensations of sound become identical, and we obtain the following formula:

Right ear armed.	Left ear unarmed.
Ca C—	—
Ca D—	—
Ca O R	R
An C R′	R′
An D R>	R>
An O—	—

Since the sensations of sound are more intense on the left than on the right, the patient hears the latter no longer clear, and his statements are inaccurate. On this account, the electrode B is applied to the nape of the neck, and thereby (on account of the greater proximity of the two electrodes and the less force of current required) the production of the paradoxical reaction is rendered more difficult. Immediately there reappears a perfectly doubtless reversion of the formula with the corresponding less strength of current. This interesting condition was repeated and confirmed in the presence of experienced colleagues.

July 19th. Patient is discharged from treatment in an essentially improved condition (after 54 sessions). The motility of the legs has become much better; walking in the dark is easy and secure; no more staggering with the eyes closed. Noises in ear very moderate. Only the eyes have not improved.

At the end of October, 1870, patient comes again, because his sight has become decidedly weaker. In other respects the improvement has remained constant. Ordered iodide of potassium.

November 5th. I had again an opportunity to examine him more accurately. The eyes are again better. He walks perfectly, also in the dark. The noises in the ears have almost completely vanished, whereas the "buzzing of gnats" still remains unchanged.

Left ear: watch heard at 1′. Conduction of the bones now present (External arrangement of experiment B upon the right hand). With 6–16 El. Stoehr., constantly the formula for simple hyperæsthesia; with 4 El. Volt. Alt. still Ca C-sensation. With a reference to the statements made formerly, we try to force an An C-reaction; although Ca gives already the closing sensation with 6 El., *everything remains quiet, with even 22 El. An C* (the same with 18 El. Volt. Alt. at An C). With stronger excitation of the armed right ear, there appears now as formerly, the paradoxical reaction in the left ear.

Right ear: hearing-distance 6′. With the external mode of experiment, and B upon the left hand, no clear sensation is obtained even with 22 El. Stoehr (*i.e.*, paradoxical formula on the left). On this account, B is applied to the nape of the neck; it produces no sensation up to 16 El., and with Ca C decidedly none at all; with An C indistinct roaring noise. I did not dare to ascend to the higher degrees of current. In this ear there is a considerable degree of irritability. We may here really speak of a true torpor of the auditory nerve. This condition is the more remarkable and striking, as it is the right ear which enjoys a considerable acuteness of hearing.

At the beginning of December, patient was still in the same satisfactory condition.

To this I must add some remarks on two fragmentary cases, which were examined with regard to some questions to be considered hereafter, and on this account deserve to be mentioned here.

CASE 10.—*Simple hyperæsthesia of both acoustic nerves.*—Frederick

Meissner, æt. 35, butcher, is under treatment for rheumatism of both shoulder-joints. When by chance I once applied the Ca upon the *plexus brachialis*, the patient declared unasked that he had ringing in the ear of the corresponding side. Through this, my attention being excited, I examined the ears more accurately.

There was found diminution of hearing for the watch; feeble conduction of the bones; external auditory canal free; drumhead somewhat dull, but light spot remaining. The galvanic examination showed a high degree of simple hyperæsthesia in both ears. Only Ca C, Ka D, and An O gave sensation; also with the strongest current An C and An D, were never accompanied by sensations. The patient makes faultlessly precise statements. It is further shown, that ringing appears in the ears with labile approximation of Ca, that this also acts like Ca C; while the labile approach of An' gives no sensation, whereas labile removal of An produces it; this works also as An O. Besides, if a stronger current is used (external arrangement of experiment, B upon the hand) the paradoxical reactions appear exactly according to the normal formula given by *Brenner* in the unarmed ear; this is the case with both ears. Even with the strength of current required for this purpose An C and An O never produce any sensation of sound in the armed ear.

CASE 11.—*Traumatic paralysis of the left facial nerve.—Obliteration of the left external auditory meatus.—Simple hyperæsthesia of the left acoustic nerve.*—Lieut. G., September 2d, 1870, during the siege of Strasburg, received a gun-shot in the region of the left ear. The ball entered the left mastoid process from behind, perforated the external auditory canal, and passed out through the parotid immediately before the left ear by a long lacerated, cutaneous wound. Facial paralysis and deafness on the left side existed from the commencement. The healing of the wound was completed by the middle of November. December 3d, patient came to me on account of his facial paralysis. *Stat. præs.* A large, horizontal, deep furrowed scar, about 2″ long, extending from the external auditory canal towards the cheek, besides scars

branching off upwards and downwards just in front of the ear. External ear shrunken at its basis. The external auditory canal is indicated by a narrow recess, into which a probe cannot be introduced. Total paralysis of the left facial nerve, with changed electric excitability, characteristic for this degree of traumatic paralysis (faradaic irritability totally extinct; indirect galvanic irritability extinct; direct remaining, somewhat increased and qualitatively changed; An C H= Ca C H).

Deafness of the left ear. Watch only heard on contact with the auricle; conduction of the bones from all sides present. The galvanic examination shows *a high degree of simple hyperæsthesia of the left acoustic nerve* (external mode of examination, B on the right hand), with 6–12 El. Stoehr. full formula of simple hyperæsthesia; with 4 El. Volt. Alt. still Ca C-sensation. *With the application of every degree of current An C produces no sensation of sound;* patient says, "All is still, the ear is closed up." At the same time the secondary symptoms (excepting facial contractions) appear in the ordinary manner.

The right ear. (The same mode of examination) gives, even up to 12 El., no sensation of sound; whereas with 10–12 Elem. *the paradoxical reaction appears in the left unarmed ear* in the usual manner. The formula for it reads thus:

	Right ear armed.	Left ear unarmed.
12 El.	Ca C —	—
	Ca D —	—
	Ca O —	R
	An C —	R′
	An D —	R ∞
	An O —	—

These observations, in the greater part often repeated with the greatest care and regard to all possible objections and exceptions, naturally lead to a series of electro-otiatrical observations. It is easily seen, that my

observations are almost universally a confirmation of *Brenner's* statements. Nevertheless their publication and the repeatedly undoubted corroboration of the facts presented therewith, are not yet superfluous, because continually opinions—and these very important and claiming great authority—are published denying the correctness of most of the facts advanced by *Brenner*. Recently *Benedict* has published quite an extensive treatise (*Vienna Med. Press*, 1870, Nos. 37, 39, 42, 43, 47, 48, 50, 51, and 52), in which, upon the strength of his own researches, he rejects everything which Brenner thought he had acquired for science, and which I was also able to confirm in a former article on electro-otiatrics.* The eminent place held by *Benedict* among the electro-therapeutists, and the claims which precisely his treatise makes upon the belief of the reader, compels me to examine his work more searchingly, and to inquire accurately into the proof of the observations and the reasons brought forward by *Benedict* against *Brenner*. In these researches, I shall rely upon my own tolerably rich experience, in these investigations, and especially upon observations made with a special regard to *Benedict's* recent assertions.

One of the most important questions is naturally about *the normal reaction of the acoustic nerve.* As is well known, *Brenner* has settled this in the most precise manner, and entirely confirmed by myself and others in spe-

* W. Erb, on the galvanic reaction of the nervous auditory apparatus. These Archives Vol. I., p. 232.

cial publications of a series of observations upon healthy subjects. Nevertheless the formula derived from these results is still strongly contradicted. This may be explained partly by the fact, that the determination of a normal formula in healthy persons belongs to the more difficult methods of examination. It is true that the examination of healthy subjects is only successful with strong currents, which cause rather severe pain. Moreover, it has been proved by me that exactly with the internal arrangement of the experiment, the establishment of the normal formula is most difficult and uncertain. However we succeed, with some practice and patience, to establish in the majority of healthy persons the normal formula, with perfect purity and without exception, in the manner indicated by *Brenner*.

In opposition *Benedict* now asserts, that *Brenner's* normal formula is not the true normal formula, but only a fragment of the correct one. The real reaction of the auditory nerve may be like that of the motory nerves, *i. e.*, sensation of sound ought to appear at every moment of irritation—only with different facility and intensity—as well with Ca C, Ca D, and Ca O, as with An C, An D, and An O. This assertion is the more surprising, as it seems that *Benedict* himself has succeeded only once in exciting a Ca O-sensation in a healthy subject, which however is very easily obtained with motory nerves.

In support of these assertions he immediately refers to three reported observations, which by no means con-

vince him who understands this branch of science. In the first place, *Benedict* has always worked with the internal arrangement of experiment and with quite unintelligent people. In this way the secondary noises (humming, buzzing, rustling, etc.), occasioned by the arrangement itself, become so prominent that it is very difficult to separate them from the real galvanic sensations of hearing. The force of current employed is so low (especially if Benedict, as is to be inferred from his terminology, uses zinc and copper elements), that it seems to me *à priori* very doubtful whether they produce any sensations of hearing with healthy persons. There is no question about the secondary phenomena (pain, facial muscular contraction, dizziness, sensations of taste, etc.), from whose intensity we could form an opinion of the strength of the current. Very suspicious, nay, even contradictory to all experience (also with the motory nerves), is the appearance of An O-reaction with the same strength of current as Ca C-reaction; indeed in the first observation *Benedict* declares, that the An O-sensation had appeared already before the Ca C-sensation. In the same observation, the only sensation which appeared is humming. This is a sensation which, in this connection, is evidently not to be accepted as a galvanic sensation of hearing. Everybody hears "humming," whose auditory canal is filled with water, especially if he is requested to observe carefully his sensations. In the second observation, the sensations certainly agree with those generally found with healthy persons. *Benedict* finds at the first exami-

nation with 7 Elem., the full normal formula of *Brenner!* Ca C roaring, Ca D, Ro ∞ — (?), An O Ro. But with the same subject he finds two days later, with $6\frac{1}{2}$ Elements Ca C whistling, Ca D whistling, An C R, An D Ro, An O Ro—thus with a weaker current there is a higher sensation of sound with Ca C and sensations with An C and An D, which formerly were not at all present with more powerful currents! The intrinsic improbability of this result is apparent to everybody. In the third observation there appears in the right (healthy) ear only sensation with Ca C and D, and with An C and An D; none with An O, and naturally still less with Ca O.

In a casuistic supplement to his treatise, *Benedict* adds some observations upon healthy persons—all females—in order to prove the correctness of his assertions. But these observations are all so imperfectly reported, that it is impossible to judge them with any certainty. Already in the first case, a girl, 16 years old, Benedict asserts to have observed Ca C R with 5 El. and *external* mode of experiment. According to my experience this is unprecedented with a healthy subject. In want of any statement about the presence of facial contractions, sensations of taste, dizziness, etc., it is impossible to decide the question whether there existed an exceedingly thin epidermis or a fault of observation. As a rule there is in healthy persons (with external mode of examination) no trace of a sensation of sound, before the appearance of strong contractions of the facial muscles, and it seems to me more than doubtful, that facial contractions are excited

by 5 El. with external arrangement of experiment and second electrode on the arm.

In the following case (observation 11) *Benedict* has with the weakest force of the current of which we have any statements, *i. e.*, 8 El., received sensations of sound with Ca C and O, with An C and O; also at every moment of excitation without exception; a result, the intrinsic improbability of which is at once apparent to every expert. With the same force of current, sensations of sound appeared with Ca C, if Ca was applied upon the cervical plexus or upon the masseter muscle. The two following observations are still more defective.

This then is the material with which Benedict thinks to overthrow the observations made by *Brenner* and *myself* in the most exact manner. It is painful for me to state, that such and similar observations simply prove nothing. Benedict's assumption that Brenner's normal formula is only the more easily producible half of the true formula, and that *he* alone succeeded in presenting the formula in its totality and purity, is a *naïveté* which can only impose upon readers unacquainted with the subject. *Brenner* states that he had used the highest bearable strength of the current without having succeeded in producing any sensation with An S, although he hoped to find it. I have taken the same trouble with different healthy individuals, likewise without success. I cite only cases 3 and 7 from my above-mentioned article: in the first Ca C R was brought out already with 8 El. Stoehr., while there was no trace of An C-sensa-

tion with 18 elements; in the second case *Brenner's* full formula was present already with 8 El., but even with 14 El. there was still no trace of An C-sensation (and this was a musician!). What does it signify if *Benedict* obtained no distinct reaction with 6 El. (1st observation), but with 6½ (!) El. obtained Ca C-, An C-, Ca D- and An D-reactions! or if in the 2d case he obtains with 7 El. Ca C-reaction and no An C-reaction, but with 6½ El. Ca C-reaction and An C-reaction! And now even the cases of simple hyperæsthesia of the acoustic nerve, when Ca C is answered by clear sensations of sound already with 2, 3 and 4 elements, while with An C there is no trace of such a sensation even with 10–16 El.

Certainly, against such figures Benedict's assertions, that we had not increased the strength of current sufficiently, in order to obtain the true and complete normal formula, seems simply ludicrous, and I live in the conviction that *Brenner* and "his epigones," at all events, have increased the current to a higher degree than *Benedict*, and that they must regard the formula advanced by them as the true one.

Benedict is also in error if he thinks we had accepted *Brenner's* normal formula, because we started from the supposition that Pflueger's formula was transferable to the healthy subject! On that account we ought to have expected An C- and Ca O-sensations, for Pflueger's law of contraction demands, as is well known, reaction from all kinds of excitation (with the lower and medium strengths of current). That Pflueger's views

are nevertheless transferable without constraint to the living man, as soon as the topographic anatomical relations and the course of the loops of the current are considered, is proved beyond doubt in a recent treatise by Filehne.*

In the ear the anatomical arrangement of the auditory nerve and with it probably also the course of the loops are such that the relations are otherwise than with the motory nerves, so that the polar effects, under ordinary circumstances, already find their pure expression.

If we, notwithstanding our acquaintance with the law of motory contraction, find the formula of the reaction of the auditory nerve to be as Brenner first gave it, this does not happen for the sake of some physiological theory, but because we are unwilling to put any constraint upon facts.

From healthy acoustic nerves—notwithstanding *Benedict's* contradiction and his observations quoted above—with the best desires we could obtain no other sensations, than by Ca C, Ca D and An O, at least with the strength of current safe to be applied to the head. Last summer I made new observations upon this point long before the appearance of *Benedict's* articles, especially with a view to disperse the doubts of professional friends, who came to me unconvinced. I have always succeeded in this, even with those who had elsewhere not been successful with similar experiments. I have not the least reason

* **Filehne. The electro-therapeutical and physiological methods of excitation. German Archives for Clinical Medicine, Vol. VII. p. 573.**

not to accept the An C-reaction; but I want to see it demonstrated only once in an indubitable manner. I have taken great trouble to obtain it in myself, as well as in others. The results have always been negative in so far, as with An C never a distinct sensation of sound was produced, although it was easily effected with Ca C and An O.

On myself I hoped easily to arrive at a conclusion in reference to this subject. I have with Ca C a clear, high, metallic sensation of sound, similar to spontaneous ringing in the ears. Now if I change to An C with 2–6 elements more than are necessary to produce the Ca C-reaction, severe vertigo and heaviness of the head make their appearance, and with more accurate attention I believe to perceive a very weak, tender, and continuous rustling, which rather increases than diminishes with the duration of the current. It has not the remotest resemblance to the marked sensation of sound appearing with Ca C or An O; it is also much more present with An D by the side of the galvanic sensation proper. On this account I cannot accept this peculiar sensation as a sensation of sound; I must rather, from the comparison of the wholly indubitable statements of the other persons examined, assert also for myself, that An C is not followed by any sensation of sound. I am not prepared to give any explanation of the soft rustling; it seems to me to be in a certain connection with the feeling of dizziness, and under no condition is it to be compared to the true galvanic sensation of sound.

In order to decide finally—above all for my own conviction—this important question, I have recently made repeated experiments upon quite healthy ears, and the importance of the controversy may be my excuse for the communication of some more of these examinations. They have been made according to a somewhat different method, which after greater experience I now deem the more advantageous for galvanic irritation of the auditory nerve, and on this account I shall briefly describe it, because this might facilitate to many the undertaking of repeating experiments. The internal mode of examination of the healthy ear is in my opinion wholly improper, partly because it produces too much pain, partly because the resulting secondary noises may too easily cause delusions (even quite unintentionally). Therefore I only employ the external arrangement of examination, without filling the auditory canal with water (because also this can cause the delusory secondary noises), and without using salt water, the electrodes being moistened with warm water. In order to obtain the necessary force of current, I choose it as strong as possible, because thereby, as is well known to every electro-therapeutist, the irritation of the deeper-lying parts is far more easily effected. I employ as electrode for the ear a plate of 4 *Cm.* square, and I apply it immediately in front of the ear, firmly to the tragus and the parts in the neighborhood of the zygomatic arch, generally without closing the external auditory canal with the tragus. The other electrode —B—is chosen still larger and applied to the nape of

the neck. With this arrangement the direction of the loops of the current is evidently more favorable for the excitation of the acoustic nerve than with the application of B upon the hand. Besides, much less strength of current is required, since, if B is placed on the nape of the neck, generally 6–12 El. Stoehr. are sufficient in healthy people to produce the full formulæ, while with B upon hand 12–18 elem. are required for the same effect. With this mode of examination, the galvanic irritation of the acoustic nerve becomes, with some attention, a very easy operation, and he who cannot effect it is really past help. With a judiciously selected number of elements, we may frequently, even with the first or second Ca C (*i.e.* without any previous maltreatment of nerve), succeed in producing distinct sensations of sound. The examinations briefly related here were all carried out in this manner:—

William Herring, æt. 25, Prussian soldier, under galvanic treatment on account of traumatic paraplegia—gunshot wound of the vertebral column. Ears and hearing perfectly normal, October 28, 1870.

Left ear: B first upon the hand without any clear result. Therefore B is applied to the nape of the neck; immediately with 12 El. Stoehr. Ca C, a high sonorous whistling appears, very similar to spontaneous ringing of the ears. At the same time there was galvanic contraction of the facial muscles and burning sensation. After which Ca C r is distinctly produced down to 6 El. An O r appears distinct first with 12–14 El. after a long duration of the current. On the contrary no trace of a sensation appears with An C with 6–16 El.; patient declares undeniably, that he hears nothing; but simultaneously he has the secondary sensations, contractions of the muscles, dizziness with inclina-

tion to fall to the left, sensation of taste in a very pronounced manner.

The examination of the *right ear* gives precisely the same result. Here immediately at the first examination and with the first Ca C with 10. El. loud ringing. With 6–14 El. strong Ca C r^1, Ca D r> ; with 12 and 14 elements An O r, short and sharp; with 6–16 El. never even a trace of An C-sensation. Contractions of the facial muscles during the examination strongly developed and in the ordinary manner.

These examinations were repeated at least a dozen times with this patient on different days.

Joseph Hostetter, æt. 27, Bavarian soldier, under treatment for rheumatic facial paralysis, states, if the current is passed transversely through the head, that there is ringing upon the side when Ca is applied, never upon the side where An is placed. Examination of the ears, November 16th, 1870: hearing and condition of ears quite normal.

In *both ears* with 10 El. Stoehr., Ca C r, with 12 El. Ca C r, Ca D r>, An O r; the same with 14 El.—Ca C r can be produced even down to 6 El.; full formula only with 12–14 El.; therewith facial contractions, vertigo, sensation of taste are present in the usual manner. Up to 14 El. An C gives *no* sensation.

This experiment was repeated often and always with the same result.

George Rupp, æt. 21, stonemason, under treatment for traumatic paraplegia (fall from a scaffolding). Ears quite normal. Examined December 22d, 1870.

Both ears give with 10 El. Ca C ringing (high whistling). With 6–12 El. Ca C-sensation. Also An O-sensation is produced with 10 and 12 El. after a longer duration of the current, feeble and short. With 6–14 El. An C remains *without exception* unanswered by any sensation of sound; this result was also obtained several times. Secondary symptoms in this moderately developed; strong burning sensation upon the skin. Besides we refer to the cases 8, 9, 10 and 11 quoted above, where we have paid special attention to this relation with An C.

These examples may be sufficient; I could easily multiply them, because recently, with the new mode of ex-

amination, I succeed in almost every case of a healthy subject to excite the auditory nerve. To give more examples would be only a tiresome repetition of facts already communicated. The result is always the same. This fact follows from it anew—and for my conviction is quite irrefutable—*that the healthy acoustic nerve reacts only according to the normal formula, first stated by Brenner, even with the highest degree of current applicable to the head, i. e., that it answers Ca C, Ca D and An O, with sensations of sound, while it remains unexcited with Ca O, An C and An D.* Every variation from this formula, especially the appearance of the sensation of sound with the three last mentioned movements of excitation and with relatively low force of current, are to be considered as pathological.

These are the facts which have resulted from my observations. Mine and *Benedict's* views on the normal reaction of the auditory nerve are diametrically opposed, and for the reader who does not arrive at the facts by his own observations, the acceptation of the one or the other view is more or less a matter of feeling and faith. At all events, a careful critical examination of the observations communicated by both sides, in regard to their exactness and cautious execution, should suggest some hints upon which side is the correct view. I think that I may set my mind at rest about this subject. For those who desire to make parallel observations, I cannot forbear to repeat the remark, that it is only through great practice and care that we obtain the necessary security in

the technicalities, and against the frequently uncertain statements of the persons examined. The subject is dif ficult, but the given problems are not without possible solutions. When I consider how easy it is for me now, after much practice, to obtain the clearest and unequivocal results, I am highly astonished that such an expert observer as Benedict has arrived at so very different results.

There are several observations among those published in this article exhibiting, in the most exquisite manner, during the galvanic examination, the formula of *simple hyperæsthesia* according to *Brenner* (Examine *Obser.* 6, 7, 8, 9, 10, and 11). They all show the same characteristic marks of simple hyperæsthesia of the acoustic nerve as indicated by *Brenner.* The introduction of this definition seems to be very inconvenient to Benedict, and he contests it most strenuously; perhaps because exactly these cases are very critical for his assertion, since, as a rule, the true formula of reaction may be determined by them with the greatest ease, and in such an unequivocal way that the confirmation of *Brenner's* statements is inevitable. Let us examine *Benedict's* objections and see if they stand the test! Benedict begins his refutation with a polemic trick of very doubtful value, namely, with a false supposition, which he assigns to *Brenner.* He asserts that Brenner speaks of hyperæsthesia when he obtains a more complete formula than his normal formula, and besides, when this more complete formula appears with a relatively low force of current. Both assertions are incorrect. *Brenner* does not think of

speaking of hyperæsthesia if, for instance, the normal formula or any other formula is eventually produced with a lower degree of current on account of perforation of the drumhead or a very thin epidermis; and even the appearance of a more perfect formula (*i. e.*, sensations of sound at other moments of excitation than those of the normal formula) has never been brought forward as a characteristic of hyperæsthesia, either by *Brenner* or myself. Nevertheless *Benedict* asserts without hesitation, that Brenner claims this to be essential, and he draws the conclusion from it by means of a logical *salto-mortale* on the strength of his own observations on healthy persons (whose value we have already discussed above), that the whole theory of hyperæsthesia of the auditory nerve is incorrect. If anybody will take the trouble to read the chapter on simple hyperæsthesia in *Brenner's* book, he will find that *Brenner* designates the characteristics of hyperæsthesia in a very *distinct manner*, to be misunderstood only by intention; namely, the following: reaction upon much lower strength of current; sensations of much greater intensity and longer duration (so that with a certain strength of current there is Ca D ∞); finally, the magnitude and duration of secondary and tertiary irritability. Since *Benedict's* conclusions are founded upon an assertion never made by *Brenner*, and moreover since we must deny the correctness of the normal formula found by him, we may well leave uncontested the existence of hyperæsthesia of the auditory nerve until further proofs to the contrary are brought

forward. But nevertheless it is worth while to make also some remarks in its favor.

Benedict must even acknowledge, that in many people suffering from ear-diseases, the galvanic sensations are much easier obtained than in healthy subjects, but he disputes the authority to refer this easy excitation to a greater irritability of the acoustic nerve. There may exist some unknown conditions which reduce the resistances to conduction of the parts to be traversed by the current, and which would make it possible thereby, that denser loops of the current could reach the acoustic nerve and excite it in a higher degree. This condition could only be of a real physical nature, and *Benedict* also mentions such a one, viz., the filling of the middle ear with serous, salty exudation, which facilitates the penetration of the current to the auditory nerve.* Without mentioning that this favorable condition is present only in the smallest number of cases of hyperæsthesia, under these purely physical conditions changes of resistance of the skin alone can come into question, because the resistance of the skin is so great that the resistances of the other tissues are almost nothing in comparison to it. Now, it is not to be denied, that with different thickness or tenuity of the epidermis in healthy persons the force of the current necessary to produce sound is modified. But dif-

* Benedict only forgets therewith, that afterwards he pleads for the supposition of a reflex excitation of the auditory nerve, upon which the middle ear naturally can have no influence, since the reflex arch is really not partly formed by the cavity of the tympanum.

ferences so great as we find in many persons affected with ear diseases, are never met with among healthy subjects. I find, on the contrary, that in healthy persons the strength of current necessary for irritation does not vary in any considerable degree. A very good criterion for the resistance of the skin to conduction, we find in the phenomena of irritation of the other parts in the neighborhood of the ear and the exciting electrode. The intensity of the facial contractions, of the sensation of taste, of dizziness, etc. (especially with the external arrangement of examination, which I believe the best under all circumstances), correspond nearly always to the intensity of the hearing sensations. *But with hyperæsthesia of the auditory nerve this correspondence ceases entirely.* We see sensations of hearing appear where no trace appears of facial contractions, of burning on the skin, or vertigo. It follows from this that the conduction through the skin is normal, and the changes of resistance to conduction in the internal parts, which may be possible in cases of pathological conditions of the ear, can have no considerable influence upon the excitation of the acoustic nerve. We must therefore find the cause of the easier excitation in such cases in an increased irritability of the acoustic nerve.

Still more instructive are those cases in which *unilateral hyperæsthesia* exists, with a normal condition of the other ear. Here certainly the resistance to conduction is tolerably equal, perhaps with exception of the anatomical changes occurring in the internal ear,

and the conduction through the skin, muscles and bones of the same. If we now consider, that in the external mode of examination, the electric current does not pass through the middle ear, but certainly for the greatest part through the bones surrounding it, it is clear, that the important differences in the facility of excitation found in such cases are only to be referred to certain changes in the irritated nerve—thus to an increased irritability, to hyperæsthesia of the same.

But the most convincing cases for this supposition are those, where we find hyperæsthesia with paradoxical reaction upon one side, while the auditory nerve of the armed side gives the normal formula or even no reaction (see cases 6 and 11, also case 8 at last examination). The loops of the current, which after entering on the armed side are distributed through the whole cranium and partly reach the unarmed ear, are certainly of much less density than those coming direct to the armed ear, and its nerve. Even if the anatomical condition of the armed ear (viz.: some change of the tympanum, or any thing else) should afford a certain facility to conduction, yet the loops of the current meeting the nerve could not reach it with the same density as they reach the armed ear, because they do not possess this density even from the beginning. If, nevertheless, the unarmed nerve already answers with sensation of sound by a strength of current which does not affect the armed ear, this can only be explained by the supposition that the unarmed ear possesses a greater irritability than the other, *i. e.*, it is hy-

peræsthetic. I think that nothing can be said to the contrary; in this case no other explanation is possible.

The definition of hyperæsthesia of the acoustic nerve is quite correct and well-founded, and I do not comprehend how any one can struggle so strongly against it, while in a hundred cases they have no objection to speak of an increased irritability of the motory nerves and muscles, although in these cases the increase of irritability is by far not so great and striking as with the acoustic nerve. Equal rights for all!

Moreover, my observations reported above, show in several cases the so-called "*paradoxical reaction.*" I had not observed it formerly, and only recently I have convinced myself of its frequent occurrence, as asserted by *Brenner*. It is found almost in every case of well-marked hyperæsthesia of the acoustic nerve. That I observe it now more frequently may depend, probably, upon my using broad spongy electrodes with the external mode of examination, by which the quantity of the current entering the skull is more considerable, and also the loops of the current reaching the other ear are more numerous and intense. For *Benedict*, this distinction of "paradoxical reaction" is very unwelcome, and he finds that this phenomenon could "only occur to those who did not trouble themselves about the simple relations of the current's course." For Prof. Benedict the affair is really very simple, and it is truly wonderful with what facility he explains it, without recognizing the contradictions in his explanatory attempts. First, he says that the affair

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reduces itself to the loops of the current, which with a certain intensity, and a certain easy irritability of the auditory nerve of the other side, produce these co-vibrations. Thereby the author forgets again that he does not believe in any direct excitation of the acoustic nerve, and that in another place he has doubts whether the loops of the current reaching the armed ear are at all intense enough to excite the nerve of this ear. Without regard to this contradiction, we may accept as true the supposition of loops of the current which reach the unarmed ear, since we also "trouble ourselves somewhat about the simplest relations of the current in its course." But *Benedict* makes still less difficult the explanation of the vicariousness of reaction at different moments of excitation; for example, if the armed ear is in contact with Ca, the unarmed ear reacts in the sense of An, and inversely. He simply says: If the zinc pole is applied to one ear, the copper pole is at the other—the unarmed ear. He forgets in this connection that if the copper pole in this case—as it is generally with *Benedict's* experiments, and almost always the case with *Brenner's*—is applied upon the arm or hand, we cannot assert, without further ceremony, that it was at the unarmed ear. If we would with this logic proceed once from the copper pole, we should certainly have the same right to conclude, that if the copper pole is upon the hand, the zinc pole must be at the unarmed ear, through which we should arrive happily at the absurd conclusion, that both poles are at the unarmed ear. When *Benedict* adds,

in the same sentence, that the difference was only this, that there was a much more organic covering of the unarmed ear than of the armed, yet we should think that the unarmed ear must react in the same sense as the armed, only in a weaker degree; for if I separate any motor nerve, by a layer of tissue 1″ in thickness, from the Ca, and another one by 2″ or 4″ thickness, nevertheless the latter will always react in the sense of Ca, and not in that of An, although naturally in a more feeble manner. It is evident that *Benedict's* explanations are full of inherent contradictions, and, therefore, wholly insufficient. From this we perceive that he does not at all comprehend why Brenner has given the name of "*paradoxical reaction*" to this form of reaction. This is undoubtedly evident from the example which he has brought forward for a "paradoxical reaction." In the observation in question (No. 6), a co-vibration of the right unarmed ear does not appear as long as the second electrode is placed upon the right arm; but immediately as soon as the same is applied to the right side of the neck, *that is, in the neighborhood of the right ear.* This is indeed no paradox phenomenon. On the contrary, the ninth observation of Benedict, which he shows as a proof of the influence of the sympathetic nerve upon the reaction of the auditory nerves, is a pronounced case of "*paradoxical reaction*," but naturally it has not been recognized as such by the author. This ignorance is somewhat to be excused, from the circumstance that *Brenner* has not clearly explained himself, in the chapter of

his book on "*paradoxical reaction*," why this reaction seems *paradoxical* to him. He has also made no attempts of explanation, but tried to make it probable by several experiments that these symptoms are produced by loops of the current reaching the unarmed ear in a direct way. Nevertheless, had *Benedict* studied Brenner's book with the desirable accuracy, he would certainly have found the reason for himself.

Paradoxical is really only this circumstance in the whole reaction that the unarmed ear reacts in the sense of the electrode most distant from it. It is not paradoxical that a highly hyperæsthetic ear reacts, even if it is not directly armed. We see that it does so also from the neck or the supra-clavicular pit, or from the masseter, or from the vertex; why not also from the ear of the other side? But that it reacts with the ordinary arrangement of the experiment (B upon the hand or arm) in the sense of the more remote electrode, is paradoxical and surprising enough, in comparison with the general regularity of the reaction of the acoustic nerve. Brenner had, indeed, proved and placed beyond any doubt (Vol. I. of his researches, pp. 113, 121 et seq.), *that the acoustic nerve under ordinary conditions always reacts in the sense of the nearest electrode.* This point is quite indisputable, and only the phenomena of the so-called "paradoxical reaction" seemed to be an exception. For the electrode B upon the hand or arm is certainly more remote from the unarmed ear than the electrode A, and yet the unarmed ear reacts in the sense of the electrode B, as the latter

was in its immediate neighborhood. A simple consideration will show why this must be so, and why even the paradoxical reaction furnishes only a confirmation of the above law.

If, for instance, the An is applied to the right ear, the loops of the current entering into it will be distributed through the whole space of the cranium, and they will leave it, if Ca is applied upon the hip or extremities, by the way of the neck. The Ca may be placed upon any part of the body or extremities, and then every single loop of the current will be obliged to pass through the relatively narrower place of the transverse section of the neck, and for the tissues situated in the skull, the transverse section of the neck will present, under all circumstances, the point of exit of the current; in other words, it will be for all organs of the skull exactly as if the Ca was placed at the transverse section of the neck.*

Now, since the left unarmed ear is in any case nearer to the transverse section of the neck than to the armed ear, it will react in the sense of this transverse section,

* For those who look upon *the direction of the current* as the determination of the mode of reaction, this consideration may be expressed thus: with An upon the armed ear, the resultant of the loops of current meeting the acoustic nerve has the direction from the place of entrance of the current to the nerve; on the contrary, at the unarmed ear the same resultant has the direction from the nerve towards transverse section of the neck, thus towards the point of exit; therefore the alternation in the reaction. A simple schematic drawing, indicating about the direction of the loops of current with the supposed application of electrodes, shows the correctness of this view in the clearest manner.

i. e., in the sense of Ca, this may be placed as remote as possible upon any part of the body. (Naturally it will be *vice versâ*, if the right ear is armed with Ca, the left ear will react in the sense of An.) Thus the matter is explained very simply, and loses everything paradoxical. This holds equally good for every case, when the electrode B is applied to the neck, as Brenner has described one such case. The distance from ear to ear is under all conditions greater than from the unarmed ear to the nape of the neck, consequently the unarmed ear must react in the sense of the cervical electrode. Still much more simple are the relations in this condition, if the electrode B, as *Benedict* has done, is placed upon the corresponding side of the neck also, though not immediately upon the ear; this ear will always react in the sense of the nearest electrode. We see that thus the affair is very simple, and divested of every paradoxical appearance; it is reduced to simple physical relations.

The paradoxical reaction occurs in almost every case of simple hyperæsthesia. Brenner originally thought that it would appear only with especially old and severe forms of the same. I must oppose this view on the strength of my own observations (especially No. 11, also 8, 9 and 10), which showed partly the paradoxical reaction with quite recent forms, and not very severe affection of the acoustic nerve. It depends only upon the degree of the hyperæsthesia, not upon its long duration or original cause. The higher the degree of hyperæsthesia, the easier and more certain the paradoxical reaction is obtained.

On the contrary, the stronger the current and the more favorable the arrangement for the development of considerable loops of current, the more frequently we shall find the paradoxical reaction. Therefore, it is more seldom with internal than with the external mode of examination, especially if we select with the external arrangements of examination very broad plate-formed electrodes, that the conditions for the appearance of this reaction are most favorable. For this reason I have recently observed it much more frequently.

Since the matter can be reduced to simple physical relations, and to a certain degree of hyperæsthesia, I am of the opinion, that we should strike out the whole category of "hyperæsthesia with paradoxical reaction." This has nothing positively characteristic, no diagnostic or therapeutic importance.*

We will, if we can ascend to the highest force of the current, demonstrate the paradoxical reaction with most cases of hyperæsthesia. It is probably best to regard its appearance only as a sign of high degree of hyperæsthesia, without giving to it any further importance. In this way misunderstandings may be best avoided.

The inevitable *sympathetic nerve* is also, by *Benedict*, drawn into the question of the excitation of the acoustic nerve. The study of this chapter has not yet proved very fruitful; although it has yielded many interesting observations, yet up to the present time we have little

* As demonstrated by Moos, it has also no *prognostic* value. See these Archives, Vol. I., part II., on a recovered total nervous deafness, etc.

that is clear and positive. If, nevertheless, I enter somewhat into this question, I do it in order to protest in the name of scientific methods of investigation against the manner by which *Benedict* makes his observations, and thence derives his conclusions. I do not mean to depreciate the *therapeutic* results of the galvanization of the sympathetic nerve. I will not deny that there are good results, since Benedict states that it acts favorably upon the noises in the ears and deafness. As we have in most cases no idea of the true origin of the noises in the ear, we would not be justified in denying that they may be cured by galvanizing the sympathetic nerve. Experience only can decide this point. As the galvanization of the sympatheticus has undoubted influence on intra-cranial affections, it may also have some effect here.

We want very different proof from that brought forward by Benedict, in order to assert, as he does, that the excitation of the sympathetic nerve regulates the acoustic reaction. The observation (9.) reported by him is a case of Basedow's disease with double-sided otorrhœa and deafness. In the right ear is a high degree of hyperæsthesia of the auditory nerve, in the left no reaction, but after arming the left ear, paradoxical reaction in the right. Now if Benedict galvanizes the right sympathetic, so that the Ca is applied to the first ganglion (*i. e.*, to the angle of the lower jaw, near the ear), the An to the 3d ganglion, Ca C ringing appears in the ear; with reversed position of the elec-

trodes, An O ringing is produced. With the same application to the left ear, the sound of opening appears on the right side if Ca is placed in the neighborhood of the left ear; if An is placed there, the closing sound appears on the right. (We see that this is the ordinary "paradoxical reaction.") At the same time it by no means occurs to *Benedict* to be astonished that upon irritation of the left sympatheticus, the left acoustic nerve remains so strangely silent, while the right reacts so promptly. It is further stated, that also the same symptoms appear from the 1st ganglion of the sympatheticus, if the electrode B is placed upon the hand; indeed, that even if the electrode A is placed upon the 2d ganglion of the right side, Ca C, Ca D and An O are accompanied with sensations of sound on the right side. Now in these observations all proof is wanting, that the above-named ganglia are really met by the current, and if we are willing to admit this as probable, yet there is no proof that they alone are acted upon by the current. Furthermore, all proof is wanting—and this is still of greater importance—that with this arrangement of examination the auditory nerve itself is *not* touched by the current. (According to the laws of the distribution of the current it is much more certain that it is touched.*)

* I see from a corrected copy of *Benedict's* treatise, that he obtained the same results from some of his parallel experiments. Formerly a typographical error, destroying the sense, was likely to occasion a very fallacious interpretation. A more accurate proof-sheet is especially desirable for the "*Vienna Med. Press.*" Such an accumulation of the most laughable and sense-disturbing typographical errors, as in the quoted treatise, I have seldom met.

According to the simplest principles of induction, the conclusion that the excitation of the sympatheticus has produced the hearing sensations, is entirely incorrect; the proof is entirely insufficient. Nevertheless, *Benedict* inconsiderately draws the conclusion from this observation, that we can produce subjective sensations of hearing by irritation of the sympatheticus.

It is clear that from this observation we could also assert, with the aid of the logical operation applied to the sympathetic nerve, that the *carotid*, or the *fascia colli*, or the *M. sterno-cleido-mastoideus*, is essential to the auditory reaction. The same logic for all! Some similar observations, in the record of cases, are also made with the same want of judgment and as little force of argument.

It is, indeed, necessary to protest energetically against this negligent manner of establishing scientific facts. Observations such as those previously criticised neglect the simplest rules of inductive inquiry; there is no trace of verification of the result of the observation, of changes in the condition of the observation, etc., but the observations are always interpreted so as to support the author's views, with little regard to logic. In this way of proceeding electro-otiatrics will certainly make no progress, but will fall back into the deplorable condition in which they were before the works of Brenner appeared.

The theory of irritation of the auditory nerve, brought forward by *Benedict*, is no less open to criticism. I do not willingly enter into such a theoretical quarrel; but in the

interest of the cause I cannot forbear to examine somewhat more closely the value of the "important reasons" which have caused Benedict to advance the theory advocated by him, if it be only in order to convince him that I do not read and accept everything without criticism, as he now believes.

The question at present lies thus—that *Brenner* and "his epigones," to whom I also belong, are of the opinion that the subjective sensations of hearing during galvanic examinations are produced by direct irritation of the auditory nerve. *Brenner* has brought forward a series of important facts in support of this view. In opposition to him, *Schulz*, *Benedict*, and others assert that we have here to deal with a reflex irritation from the trigeminus (and now probably also from the sympatheticus). Formerly all these observers seemed to suppose that the acoustic nerve itself was excited by reflex action; but in his most recent treatise *Benedict* attempts to confirm the supposition that by this means, first of all, the blood-vessels surrounding the acoustic nerve are changed by way of reflex irritation, and that this change subsequently excited the acoustic nerve.

The facts and reasons supporting both these views are as follows:—

1. It is confirmed beyond a doubt, that most of the nerves of the human body, motory, sensitive, and the nerves of the higher senses (the phenomena occurring in galvanic irritation of the retina are thought by the most eminent physiologists to be phenomena of direct excita-

tion) can be directly excited through the electric current, and that they react in a regular manner, apparently alike for all the nerves examined in this way.

2. It is certain beyond a doubt, that with the ordinary arrangement of the electrodes in the neighborhood of the ear, loops of the current reach the internal ear, and especially the auditory nerve. From experiments on other parts of the body (for example, irritation of the ulnar nerve at the external condyle) it is easily determined that the distance of the auditory nerve from the exciting electrode is not too great, in order to allow sufficiently dense loops of the current to reach the nerve.

3. The acoustic nerve, with the supposed arrangement, reacts to the galvanic current, according to a formula exactly corresponding to the manner of reaction of the other nerves of the body.

From these propositions there is the greatest probability (of course not yet a definite proof) of direct excitation.

But it is on the other side—1, by no means decided with certainty, that in general the reflex excitation of the sensitive nerves, and especially of the nerves of the higher senses, is at all possible. There is no fact which proves with certainty that the acoustic nerve can be excited in a reflex manner.

2. Every positive proof is wanting (there is even a want of probability) for the supposition that the acoustic nerve is not simultaneously reached by loops of the current, with the arrangement of the experiment selected by the disciples of the reflex theory.

Every proof is wanting that the supposed reflex irritation, with galvanic excitation of the sensitive nerves, appears in the regular formula, which corresponds to direct irritation. (Plüger seems—in his investigation on the laws of contractions of sensitive nerves in frogs deprived of their brains and poisoned with strychnia—to have furnished this evidence for the reflex process from sensitive to motory nerves; but for the sensitive nerves all points of support are wanting.)

Do these propositions speak in any way favorable to the supposition of a reflex excitation? Certainly not. Truly we must have very cogent reasons, in order to support reflex irritation against the near at hand and reasonable supposition of direct excitation. Now, *Benedict* declares that he has such cogent reasons. Let us examine their intrinsic value.

The first is the unequal effect of irritation in healthy persons; with some even twenty elements are without effect, with others the perfect formula is obtained with few elements. Without mentioning that we cannot see why this should speak for reflex excitation, I must dispute the fact itself in this extension. We use generally a high degree of current in healthy subjects; but if in many persons we do not succeed with a strong current, we never succeed, according to my tolerably rich experience, with a few elements to obtain a full formula in healthy persons. But even if this were true, it would not be by any means without analogy; it is known to every electro-therapeutist how very different strength

of current is necessary with different individuals for the excitation of one and the same motory nerve. I find the vacillation here exactly as great as with the auditory nerve; but I am not prepared to infer therefrom a reflex irritation of the motory nerve.

The second reason is the easy excitation of the auditory nerve, if a rheophore is placed upon the auricle. This appears now really a reason! Every intelligent advocate of the theory of direct excitation will here tremble for his theory. For if this is true, then the reflex theory is certain! and how beautifully can we here satisfy the demand of keeping the loops of the current away from the acoustic nerve itself; how easy is it to take and irritate the lap of the ear isolated between the two electrodes! Yes, if it were only true! But it is incredible, although it seems to be true. It has not even occurred to Mr. Benedict to irritate the lap of the ear directly and isolated, to place both electrodes upon the same, and thus exalt beyond a doubt its "reflexogene" relation to the acoustic nerve! If already the terms of the sentence: "if the one rheophore," etc., point to the deplorable fact of this sin of omission, the observation XI. communicated in the "casuistic" leaves no longer a doubt on the subject. Thus the "reflexogene" relations of the ear-lap to the acoustic nerve have provisionally again come to naught. If, moreover, *Benedict* thinks that the ear-lap offers no physical advantages over other parts of the skin, we can suggest, in opposition to this view, that it possesses a much more tender epidermis than

the neighboring parts of the skin, and that by this fact the relatively easier excitability may well be explained.

Moreover, in order to examine for myself whether Benedict's poorly founded statements of the reflexogene relations of the ear-lap to the auditory nerve had not some truth, and could be of any value for the reflex theory, I made the following experiments with a man who had already served many times for aural experiments, and made perfectly reliable statements. A disciform electrode (4 Cm) was placed on the nape of the neck, a button-formed electrode was chosen for the ear, and both moistened with lukewarm water. 1. Electrode upon the tragus; Ca C^r with 10 El. Stoehr., feeble, with 12 El. strong, with contractions of the facial muscles. 2. Electrode upon the ear-lap, 10, El. nothing; Ca C^r with 12 El. distinct; also simultaneously facial contractions. 3. Both electrodes are placed upon the ear-lap. The button-formed on the anterior and the disciform on the posterior surface. Therewith lively sensations of burning, and painful contractions of the auricle, but even up to 24 El. (!) no trace of sensation of sound, either with Ca C, or with An C, nor with Volt. Alternatives. The result was the same for both ears. We conclude from this, that at least in this case, the application of the exciting electrode upon the auricle does not facilitate the production of hearing sensations, and that, at all events, no sensations of hearing can be produced in a reflex manner from the ear-lap. In another case the same method gave exactly the same result.

The fact of the easy exhaustion of the acoustic nerve —*i. e.*, that with increasing force of current the excitability of the acoustic nerve soon fails—is also mentioned in favor of the reflex excitation. *Benedict* thinks that he has established this phenomenon. But the observations reported in support of this view suffer from the principal defect, that they do not prove that with increasing num-

ber of elements the force of the current in the closing arch is really augmented. The method employed by the author of applying paper pads to the surface of the body makes this defect of experiment very probable. On this account I consider the existence of this exhaustion not to be proved; Benedict has only found it now and then with healthy persons. If this easy exhaustion for reflex irritation were characteristic, as Benedict asserts, we must, according to his theory, find this easy exhaustion of the acoustic nerve with the majority of healthy persons. But this is decidedly not the case.

The fact discovered by Türck, that pressure upon the cervical vertebræ or the mastoid process has either an aggravating or improving influence upon hardness of hearing and noises in the ears, is said to be of greater importance. This fact we shall not deny, although it is exceedingly rare. But where is it proved that its mechanism is a reflex excitation of the acoustic nerve? This is just as little proved as the reflex excitation of the acoustic nerve by galvanism. We cannot prove anything by a proposition which is unproved itself. If *Benedict* explains Türck's phenomenon as a reflex process, I have nothing to say against it, although the sometimes observed diminution of noises in the ears by external pressure does not seem to me to speak exactly in favor of a reflex excitation of the acoustic nerve; but he has no right to infer anything further from this unproved supposition.

The last three reasons brought forward by Benedict: that Dr. Winternitz had obtained improvement of deaf-

ness and noises in the ears through the application of the "*Douche filiforme*" upon certain places of the skin; that slight rubbing before the ear increases enormously the noises with many patients (Politzer); and finally, the existence of noises with pathological processes in the external auditory canal, belong to the same category; they all prove nothing for the reflex excitation of the auditory nerve. At best they can only prove that the causes of noises (which are mostly unknown) and of deafness can be modified in a reflex manner from these parts of the skin; so that, for instance in hyperæmia and catarrh, the pressure upon the water in the labyrinth can be influenced thereby. These phenomena cannot be cited in support of the supposition of a reflex irritation of the auditory nerve.

We see therefore that all the "cogent" reasons advanced for the reflex excitation of the acoustic nerve prove as much as nothing. *Benedict* also seems to have felt this when he propounds the question to himself, whether the reflex process acts upon the acoustic nerve itself, or the blood-vessels surrounding it: and he comes in his considerations to the conclusion that, in fact, the reflex contractions and expansions of the blood-vessels of the acoustic nerve are the real cause of excitation, and that they represent the intermediate link of the galvanic irritation.

It is a known fact that reflex contractions and expansions of the vessels do occur, tehrefore *Benedict's* view is possible; let us see if the reasons are correct which he offers for it.

The first question is, whether *Benedict* can prove, or make only probable, that the ramifications of the *Art. auditiva intern.* can be influenced in a reflex way. For this possibility he only adduces the circumstance, that mechanical irritation of the external auditory canal can produce hyperæmia of the *membrana tympani*, and also of the promontory and the whole cavity of the tympanum, as may be observed in cases of perforated membrana tympani. The hyperæmia of the drumhead and promontory, as we observe it from electric irritation, *Benedict* justly declares not to be an argument, because it could depend also upon the direct influence of the current; therefore *Benedict* concludes without hesitation that the supposition is certainly not to be rejected, that with irritation of the earlap, for example, an influence will be gained upon the blood-vessels of the auditory nerve. And from this (in connection with the facts found by *Türck*, *Winternitz*, and *Politzer*, and known as being not unequivocal) he draws the conclusion, that the electric irritation influences the circulation around the acoustic nerve, and that the produced contraction or expansion of the vessels is the cause of the subjective hearing sensations. Upon the following page he directly asserts, that *it is determined* that the reflex irritation of the acoustic nerve is accomplished, partially at least, by the aid of the vaso-motory nerves, and "that therefore it is lawful to regard the galvanic irritation of the auditory nerve on one hand as dependent upon reflection to the vessels of the nerve, and on the other hand as resting

upon direct excitation of the vessels of the auditory nerve.

This now is Benedict's new theory. In order to save himself from the theory of direct excitation, the author wanders off into the territory of the vaso-motory nerves! Thus the phenomena of galvanic irritation depend upon the vessels of the acoustic nerve, and the vessels of course are either changed by reflex, or—what a serene contradiction lies in this concession—they are *directly* excited. The vessels of the acoustic nerve are directly excited, but the *acoustic nerve itself* cannot be directly excited.

It is really superfluous to say anything against this hypothesis; it has so much intrinsic improbability that a refutation is by no means necessary. But when such a hypothesis is covered by an honored name, and obtains through it as it were a free pass, it is still more our duty to show clearly its groundlessness.

Aside from the already proved uncertainty and deficiency in the foundation of this hypothesis, each and every point of support is wanting that the acoustic nerve can be excited at all by contractions and expansion of its vessels, and especially in a strictly regular manner. Every positive proof is wanting that the change in the diameter of the blood-vessels of the auditory nerve can produce the peculiar sensations of sound appearing with galvanic irritation. Besides, there is a want of proof that the vessels react in such a regular and prompt manner with direct or indirect irritation upon closing or opening the chain, as the acous-

tic nerve does upon galvanic irritation. On the contrary, everybody knows that the direct as well as the reflex contractions and expansions of the blood-vessels follow slowly, and that they last a long time, frequently far beyond the duration of the excitation. This can be easily proved with the cutaneous or conjunctival vessels at any time; and it can well be demanded from the founder of this wonderful theory, that he should have demonstrated on these easily accessible parts the possibility of so prompt contractions and expansions of the vessels as his theory inevitably demands. If we compare with the well-known slowness of reaction of the smooth muscles in general and of the muscles of the vessels in particular, the exactness and precision with which the sensation of sound, for example, sets in momentaneously with Ca C, in order to disappear again just as suddenly with Ca O, or the momentary sound, which appears with An O—and we shall immediately understand that contractions and expansions of the vessels never are and never can be the cause of the galvanic sensations of hearing.

But enough is said of this wonderful hypothesis! Against it the theory of direct excitation has an easy case. It does not occur to me here to adduce further evidence for the latter: already the proof of the intrinsic groundlessness of the reflex theory speaks enough in its favor. Besides, *Brenner* has brought forward a great many experiments which confirm the correctness of direct excitation. The sneer and contempt with which Benedict treats these experiments of *Brenner* cannot detract any-

thing from their merits, nor cover the weakness of the objections which *Benedict* advances. Even Benedict must accommodate himself to the assertion, that reflex excitation ensues only with great difficulty upon simple excitation of the reflexogene places of the skin, and that the current must penetrate into the deeper parts to cause reaction, in order to bring forward one argument against *Brenner's* experiments, which prove that the resistance to the penetration of the loops of the current into the deeper parts prevents also the appearance of sensations of sound!

Against a theory founded in this way, we will indeed without hesitation dare to remain with the theory of direct irritation.

Almost in all the observations reported by me, the affections of the ears are combined with other affections on account of which the patients sought my aid. The reported affections of the acoustic nerve are, therefore, only the accidental results of a practice having wholly other categories of disease for its object. Therefore we may infer the frequency of such affections of the acoustic nerve in the ambulatory practice of the otologist.

We may distinguish without constraint three groups among my cases: the cases from the first group, in which the disease of the acoustic nerve is combined with traumatic facial paralysis; into the second group fall the combinations with paralysis of the ocular muscles; and into the third group the combinations with central (cerebral or spinal) affections.

Only Case 11 of the cases above reported belongs to the first group. But I have published already in a previous paper (German Archives for Clinical Medicine, vol. vii., pp. 246) two quite similar cases, in which traumatic facial paralysis was also accompanied with hard hearing, noises in the ears, and hyperæsthesia of the acoustic nerve. I have given the opinion in reference to this case that probably the hyperæsthesia originated (according to *Brenner's* theory) in consequence of changes brought about in the sound-conducting apparatus by the trauma, and it was probably *not* the direct result of changes taken place in the acoustic nerve itself. Nevertheless this question could not be finally decided then. This is not possible, either, through the above-mentioned case No. 11. We may say here with some certainty that the auditory nerve was not affected directly through the trauma, as it seemed not to extend so far; therefore the hurt can hardly be the direct cause of the hyperæsthesia. It is also a proof for this assertion that the watch is not heard on contact with the ear, and that the conduction of the bones still exists. Consequently, the obliteration of the external auditory canal (possibly also destruction of the *membrana tympani*, etc.), and the prevention of the conduction of sound resulting from it, remain as the cause of the hyperæsthesia. We are brought back with this to the original theory of Brenner, according to which affections of the sound-conducting apparatus can be followed secondarily by hyperæsthesia. If it would be once possible to examine carefully one such case in regard

to this question, and to confirm that the labyrinth and auditory nerve are anatomically intact, we would obtain very important proofs for this hypothesis.

To the second group belong the combinations of hyperæsthesia of the acoustic nerve with paralysis of the ocular muscles. Brenner first pointed out the frequent coincidence of hyperæsthesia of the auditory nerve with paralysis of the muscles of the eye depending upon intercranial causes. These are cases in which probably an inner direct connection between both affections exists, in consequence of the central process, and, therefore, these cases would form a subdivision of my third group. Hagen* also has published one such case.

The above reported cases, Nos. 6 and 7, show certainly only accidental complications of both affections. In each of them the affection of the ear existed much longer than that of the eye, and independent of it, and the appearance of hyperæsthesia can be traced back to the present affection of the ear without constraint.

To the third group finally belong Cases 8 and 9, both combinations of the hyperæsthesia of the acoustic nerve with decided central disease. In the first case we have a cerebral affection manifesting itself, among other symptoms, as it seems by phenomena from the side of the hearing organ. Whether the noise in the ear was really a cerebral symptom, or only the consequence of a coexisting affection of the ear, cannot be easily decided, because in our case such an affection of the ear existed. I

* R. Hagen's Practical Contributions to Otology. Vol. i., pp. 76.

cannot decide whether this affection of the ear, as Benedict presumes in such cases, is to be regarded as of a central origin, and a kind of trophoneurosis (similar to neuro-retinitis, which frequently accompanies cerebral affections). At all events, this is a hypothesis worthy of consideration, although for its foundation the case in question cannot be used.

The same is true of Case 9, in which we see the ear disease in combination with a decided spinal affection, which is accompanied by pronounced cerebral phenomena, and even by neuro-retinitis. Here also the symptoms of the ear seemed to have appeared later than the spinal and cerebral; but we find also evident changes of the middle ear. Here also the question arises again, whether it is a trophoneurosis or an accidental complication. This question cannot be decided with this case; for this purpose, further numerous observations are necessary. The condition of the right ear is remarkable in this case: the reversion of the normal formula, and finally the great diminution of the excitability of the auditory nerve with relatively good acuity of hearing. But exactly this symptom appears to point to a cerebral origin of the anomaly of reaction. Recently I have observed also in one of two other cases of cerebral and spinal disease, respectively, the appearance of An C sensation in both ears. Perhaps this might be a symptom to be further considered in central affections.

At all events, there is nothing certain to be concluded from my two cases about the connection of the anomalies

of galvanic reaction of the acoustic nerve in central affections. Indeed in this connection, three probabilities present themselves: 1st, that the central disease changes directly the quantitative or qualitative excitability of the auditory nerve, in a similar manner as has been observed of motory nerves; or secondly, that in the course of the trophoneurosis anatomical changes of the auditory nerve occur (analogous to secondary *neuritis optica*), which cause the anomalies of reaction; or finally, that in the same manner changes are caused in the middle ear and sound-conducting apparatus generally, which produce only secondarily the anomalous reaction of the auditory nerve. Only numerous observations will be able to decide whether one or several, and which one of these are present; and for this reason we recommend these interesting cases to especial consideration.

There are some evident examples among the above-reported cases of the *therapeutical results* of galvanism in affections of the auditory nerve. Truly they are not quite pure observations, because they mostly concern patients who were treated on account of other diseases. Moreover, it is difficult to determine in Cases 8 and 9 how much is to be ascribed to direct treatment of the ear, and how much to the improvement of the primary affection.

My observations (Cases 7, 8, and 9) showed with perfect certainty *the favorable effect of AnD upon the noises of the ear accompanying simple hyperæsthesia.* In all these cases the noises were silenced by a suffici-

ent strength of current, and after a careful diminution of the current they did not return for either a shorter or longer time. By the continuation of this treatment the noises are finally cured, or at least reduced to a minimum.

My observations show further, that with the improvement of the noises and increase of acuity of hearing, the previously increased galvanic irritability of the acusticus decreases and comes nearer the normal condition. This is a proof that the galvanic hyperæsthesia and noises of the ear are in a certain connection. This is especially evident with Cases 7 and 8. In Case 9 the conditions are much more complicated.

Finally, from Cases 7 and 8 we may conclude, *that CaC and D have an aggravating influence upon the noises of the ear;* the same is true of a sudden *An O*. On this account I doubt whether we are able to treat noises in such cases successfully with CaC. The remarkable statement of *Benedict*, that voltaic alternatives are the best treatment for noises of the ear and hardness of hearing, I was unacquainted with at that time, otherwise I should not have omitted to examine it. At present I am unprepared to give any opinion about it.

Finally, some remarks may be allowed me in reference to the technicalities in the galvanic examination of ears. Benedict looks down with sovereign contempt upon the expedients of examination recommended by *Brenner*, especially upon the commutator and the rheostat. He finally concedes to Brenner, in the whole question, hardly

anything but the merit of an exercised practitioner, and is not a little conceited that he makes the examination without the two above-mentioned instruments, through simple manual closing and opening on the body, and that thereby he receives more complete formulæ. Whether the formulæ founded and facts reported by *Benedict* are very recommendable for his method of examination, I leave to the judgment of the reader. At all events, it is true the examination can also be made without any special instruments; but with ease and security it is certainly not made.

Yet the rheostat is the most dispensable. I have convinced myself, through repeated examinations, that it does not allow a simple and comparable gradation of the force of the current; that also, with its use, the electromotory force of the battery is soon exhausted. On this account the gradation of the strength of the current, through changing the number of elements, is sufficient for the examination of most cases. But for exact and scientific examinations, for exact comparison of one and the same process, etc., the rheostat might still be of great value, especially if the precaution is taken to use with it always the same battery and same number of elements. Finally, it is not at all perfectly indispensable in those rare cases of so high a degree of hyperæsthesia, that even diminution of the elements by 2 or 1 still produce sensations of sound with gradual diminution of the current. In such cases we will not be able to do without one or the other rheostat. Nevertheless, the

complicated and very expensive rheostat of Siemens-Halske is an instrument quite dispensable for ordinary practical purposes.

On the other hand, I believe the commutator to be entirely indispensable for examinations of the ear. Especially for the unexercised, the examination becomes easy and convenient with its aid. The exactness and precision of opening and closing, as is possible by means of the commutator, can never be accomplished by the hand. Voltaic alternatives are naturally only executed with the commutator. But exactly in examinations of the ear, everything depends upon a most precise manipulation of the opening and closing; therefore I cannot strongly enough advise the unexercised, and especially all those wishing to repeat examinations of the ear, to use the commutator.

We cannot point earnestly enough to the necessity of parallel examinations, in order finally to bring these pending interesting questions to a definite solution. But it cannot be too strongly impressed, that only examinations made with a knowledge of the facts, and with precaution, without prejudice and animosity to the investigations proposed, will be permitted to influence the final decision of these questions.

HYPEROSTOSIS OF BOTH PETROUS BONES; BONY CLOSURE OF THE LEFT ROUND WINDOW, OF THE RIGHT UPPER, AND THE LEFT UPPER AND POSTERIOR SEMI-CIRCULAR CANALS.

By **WILLIAM HACK**, Medical Student, Heidelberg.

Translated from the German by Thos. R. Pooley, M.D., of New York.

The anomaly which I am about to describe, I had the opportunity to observe in the dissecting-room of the Anatomical Institute, under the kind guidance of Dr. Arnold. Unfortunately it was not possible to obtain any details of the past history of the individual in question, other than the fact that the corpse from which the specimen was taken was a female. The examination showed the exterior parts of both ears to be normal. The middle ear was also normal as to size, topographic condition, and its lining membrane; the membrana tympani, the mobility of the ossicles and membrana tympani were likewise normal. But the round window of the left side was closed by bony substance. The roof of the tympanum of both sides was of considerable thickness and hardness. Both petrous bones were unusually enlarged. The *sinus petrosus superior* was changed into a semi-canal; the most marked on the left side, where this canal had a width and depth of 1‴. The examination of the cavities of the labyrinth showed that on the left side the superior and posterior semi-circular canals

were closed by bony substance. The ampullary end of the superior semi-circular canal was still open; but we found in the middle of the canal a small ridge, which gradually enlarged above; on the highest point of this semi-circle the canal was completely closed, and by this means the connection of the posterior semi-circle with the non-ampullary end of the semi-circular canal was destroyed. The non-ampullary end of the posterior semi-circular canal was in connection with the vestibule, but its ampullary portion showed a funnel-shaped contraction, and was lost in the bony mass of the inner wall of the vestibule. On the right side also, which was examined by Mr. A. Hildenstab, medical student, the superior semi-circular canal was in like manner closed; but the posterior canal communicated in a perfectly normal way with the vestibule. The other parts of the labyrinth were normally developed.

The history of development throws very little light on this case. The semi-circular canals are formed in the ninth week of gestation by offsets from the vesicles of the labyrinth; the superior and anterior canals are formed first (Arnold). An early arrest of the development of these canals might give us an explanation of this condition, especially if we take into consideration again that the superior and anterior canals are the first to ossify (Arnold, Kölliker). But as the surface of the whole petrous bone was hypertrophied, a nearer cause for the abnormality may be found in an exterior irritation from pathological conditions after birth.

Let us still consider the influence which this malformation had upon the functions of the labyrinth. First must be noticed the bony closure of the round window, by which the sound-waves were considerably arrested. For even if they, through the complete mobility of the stirrup, were conveyed to the fluid of the labyrinth, this fluid could not be caused to vibrate so extensively as is possible in the normal condition of the round window and its membrane. On the other hand, the closing of the semi-circular canals could hardly produce an essential disturbance of hearing, as they do not directly conduct the sound-waves, but only condense them by resonance of their bony walls to the *sacculus hemi-ellipticus*. In fact, comparative anatomical examinations (Hyrtl) prove that animals with acute hearing, like all ferocious animals, have very narrow semi-circular canals. But in another respect this anomaly might have produced an essential disturbance of function. The latest researches by Golz make it appear probable that the semi-circular canals serve to maintain the equilibrium of the head and the whole body. Bilateral injury of a semi-circular canal renders the maintenance of equilibrium impossible, and produces attacks of vertigo with every movement, even after the cicatrization of the wound. It is probable also that in our case similar symptoms were present during life; the more it is to be regretted that the antecedents of the individual were not known, which might have served to corroborate this plausible hypothesis.

FIBROMA OF THE SCLEROTIC.

By Prof. Th. SAEMISH, of Bonn.

TRANSLATED BY C. C. TERRY, M. D., OF NEW YORK.

Mary B. of Siegen, æt. 10 years, entered the eye clinic June 8, 1869. Within a year she has observed a diminution of sight in the left eye, which gradually increased without any symptoms of irritation, and about 6 weeks ago the eye became totally blind, coincidentally with the sudden appearance of severe pain in the surroundings of the eye and the occiput. At about this time there was observed a remarkable change in the appearance of the eye.

The left eyelids are slightly swollen, not red; a number of very full and tortuous veins run over the conjunctiva bulbi, and at the margin of the cornea there is a deep subconjunctival injection. The cornea is only slightly opaque, and so transparent that we can make out a considerable flattening of the anterior chamber, the light-green iris, and, in the widely dilated pupil, a yellowish gray reflex. This reflex is caused by a mass lying close behind the transparent lens, which has a smooth bulging surface and projects forwards in the form of two bosses, one outward to the other, and both in contact in the vertical meridian. The tension of the eye is considerably increased, and the bulb protrudes about 18 mm. forwards and outwards. Motility is limited on all sides, especially inward. Sight abolished.

The diagnosis appeared very easy and certain, and it was considered to be an intra-ocular tumor which had lately perforated backwards. The youth of the patient, the yellowish reflex from the masses in the pupil, and the recently rapid growth, led to the conclusion that it must be a glioma. For this reason an immediate enucleation of the bulb was

advised, and performed. It then appeared that the posterior half of the bulb inwards from the optic nerve was the seat of a dense tumor mass. The section of the optic nerve appeared normal. Healing followed in a short time without any untoward event, and up to the present (Dec. 1871) there has been no relapse. The patient otherwise enjoys excellent health.

The *macroscopic examination* of the bulb, opened in the horizontal meridian, showed the following: there escaped a few drops of a thick, yellow material resembling thick pus, and consisting of round nuclei. The lens was pressed forward, and the retina totally detached, but so folded together that the right and left halves lay in contact by their smooth surfaces at the axis of the eye and then bent around, close behind the lens, the line of anterior attachment. The vitreous chamber did not exist. In the region of the optic nerve and further outward the choroid with the retina was united to a broad solid mass, 2 mm. in thickness. Elsewhere it was unchanged and had its normal position. The subretinal space was filled with a pulpy, compact mass of a yellow color. *No vessels* could be found in a small quantity shaken with water. This mass could easily be removed from the retina, upon which it merely lay. From the optic entrance inward, a tumor, 10 mm. long, 8 mm. wide, and 5 mm. thick, was located upon the outer surface of the sclera, extending to the optic nerve, and so intimately attached to the elsewhere unchanged sclera, whose inner surface at the affected place was entirely normal, that the outer surface could not be distinguished from the sub-

stance of tumor. The globe was hardened 8 weeks in Müller's fluid.

The minute examination showed the following conditions: the retina exhibited in the neighborhood of the papilla remnants of the fibrous layer, here and there a few ganglia, but no trace in the anterior sections. In general it consisted of nuclei resembling the elements of the internal granular layer, and so occupied the inner layers that here nothing else was to be found. The outer layers, on nearly every section, showed the following peculiar changes: the membrana limitans externa, still pretty well recognizable and bearing the remnants of the much altered rod-layer, did not extend in a straight line but in closely packed curves which were 9.09 mm. wide at the base and 0.18 mm. high, and many of them flattened together. This rather papillary outgrowth of the retina is occupied partly by the external granular layer which accompanied the proper outlines of the limitans externa as a stripe, and partly by the hypertrophied radiate fibres which are projected into the midst of the papillary outgrowths as tufts, which did not reach far enough to break through the limitans externa. In the intergranular layer thus locally expanded, there lay some elements of the granular layers, but so sparsely that the connective tissue element preponderated. There was also hypertrophy of the radiate fibres, and of the corresponding connective-tissue nuclei which occupied the inner layer of the membrane, whilst the radiate fibres had crowded the external granular layer, limitans externa, and rod layer into the

papillary outgrowths. The portion of the retina lying outward to the papilla was exceptional to the above description, inasmuch as it was coherent with the choroid by means of a solid mass of 2 mm. in thickness, and here consisted only of closely aggregated elements of the granular layer, permeated by fibrous tissue which increased toward the choroid, into which it merged. Of the choroid here only some remnants existed—epithelial cells lying far apart, a few vessels lying in a fibrous tissue of double the normal thickness, and a few elongated, faintly pigmented stroma-cells poor in processes. There were also some heaps of roundish nuclei. A piece of the optic nerve 6 mm. long was removed with the bulb; it appeared entirely normal. The choroid was comparatively little changed, with the exception of the above mentioned portion, 6 mm. long, lying next to the papilla. When it was drawn aside there adhered to it some white dots from the subretinal mass, and the removal of these dots was accompanied only by some slightly atrophied epithelium. The little white masses consisted of roundish nuclei and numerous large fat-cells. In some places the atrophy of the epithelium was very evident, for here and there were only insular heaps of small, elongated cells almost devoid of pigment. The structure of the choroid was still apparent. In the outer layers were normal pigment cells; but at some points the intervascular spaces were filled with closely aggregated nuclei, most numerous in the scarcely perceptible capillary layer, but sparser in the outer layers, where they were grouped around the large vessels.

The subretinal space was occupied by a mass consisting only of round nuclei, between which neither stroma nor vessels could be made out.

The tumor spreading outward upon the sclera and merging into it without special demarcation, consisted of a fibrous connective tissue which in torn preparations appeared extremely wavy and interspersed with here more, there fewer, cellular elements, which exhibited the development of fibre from round cells in all phases; so that here was a connective-tissue neoplasm in luxuriant growth.

The anterior section of the bulb, the cornea, iris, and lens exhibited no noteworthy anomaly.

The anatomical diagnosis was accordingly: *extra-ocular fibroma of the sclera and a circumscribed intra-ocular fibroid degeneration of the choroid and retina.* Connective-tissue hypertrophy of the retina and detachment of the retina from the choroid, which was locally infiltrated by a considerable quantity of pus furnished by the retina. In the development of the changes it would appear that, in the first place, a fibroma commenced on the sclera in the neighborhood of the optic nerve, extending to the nerve and compressing it slightly on the nasal side, growing inward and implicating the choroid and retina to a limited extent in a fibroid degeneration, giving an impetus to the peculiar hypertrophy of the radiate fibres and the remarkable suppurative process in the retina, by which it was detached and the choroid secondarily infiltrated.

Therefore, the anatomical in no wise agreed with the clinical diagnosis, which was of glioma. Hence, we must answer the question how this disagreement occurred, and whose fault it was. Although it cannot be denied that the therapy in the one case would be indirectly identical with that in the other, still the prognostic judgment would be essentially different if we had to deal with a glioma instead of a fibroma.

The diagnosis of glioma rested upon the following morbid phenomena: 1. Increased hardness of the bulb, together with other data evincing increased intra-ocular tension, as congestion in the anterior ciliary veins, flattening of the anterior chamber, dilatation of the pupil, etc.; 2. Abolition of function, with the peculiar yellowish reflex from the two masses behind the lens, which must be considered as solid; 3. The age of the patient; 4. That the visual disturbance had been observed a year previously, but had gradually increased to total blindness lately, and coincidently with severe pain and protrusion of the eye. This circumstance justified the supposition that the glioma had increased rapidly within a short time and become extra-bulbar.

I believe that under these conditions any one, even with a larger experience with tumors than I have had, would have come to the same opinion.

No one would suppose that the two elevations were produced by a total detachment of the retina, and such a quantity of thick pus in the subretinal space as to give them a yellow tint, because in this case the

changes which usually accompany the collection of so much pus in the interior of the bulb were absent, viz.: swelling of the lids, chemosis, discoloration in the iris, turbidity of aqueous, and perhaps also hypopyon. None of these changes were to be found. And we would be just as unlikely to consider the exophthalmos as an accompaniment to an intra-bulbar suppurative process, as it is observed in panophthalmitis, where, as is well known, Tenon's capsule and the retro-bulbar fatty tissue participate. As the upper lid was neither red nor swollen, nor the globe pushed forward in the axis of the orbit, the present exophthalmos could be regarded only as the product of a tumor situate upon the posterior section of the eye.

I must still consider the question how far the clinical course of the disease explains the anatomical data. Here, it seems to me, there is but one difficulty, viz.: that if the tumor were primarily extra-bulbar, with limitation of visual power later and in consequence of pressure upon the optic nerve, we should have expected the appearance of diplopia amongst the functional lesions. But there was no double vision. However remarkable this may appear, it is not a unique case of speedy abolition of the common focus in consequence of dislocation of the bulb. I remember several cases in which orbital tumors have dislocated healthy bulbs without the patient mentioning diplopia. Moreover, we may suppose that the visual disturbance in consequence of the growth of a tumor near the optic nerve was, perhaps, considerable from the

beginning, without the patient having sufficiently distinguished the diplopia. This I believe to be the probability. That the gradual protrusion of the bulb from the orbit first attracted the attention of the family when the pain and abolition of the function caused the patient to make special complaint, is not very remarkable; and this circumstance cannot be used as an argument against the conception that the extra-bulbar tumor was primary.

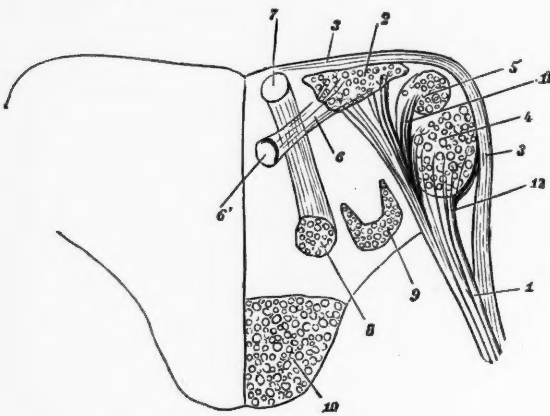
As far as I know, this is a unique case of fibroma of the sclera developing upon the posterior section of that membrane; and at the same time it furnishes evidence that the subject of ocular tumors, to which so much attention has been given of late, is not yet fully elucidated.

The above case is more exhaustively considered by Dr. C. Rheinen in his dissertation, "Ueber einen fall von Fibrom der Sklera, Bonn, 1870."

SUPPLEMENT

CONCERNING THE ORIGIN OF THE ACOUSTIC NERVE IN THE BRAIN.

IN the paper "On Vertigo, occurring in Affections of the Ear," by Dr. Gustav Brunner, of Zurich, which was published in the first number of the present volume of these Archives, the following wood-engraving, representing a diagram of *the entrance of the acoustic nerve into the medulla*, has been omitted. It should have been inserted into the middle of page 328, No. 1, Vol. II.



Explanation of the figure.

1. N. acusticus.
2. Nucleus of acoustic n.
3. Striæ acusticæ.
4. Corpus restiforme.
5. Funic. cuneat. et gracilis.
6. Entrance of the acoustic cord into the nucleus of the acoustic nerve.

6'. Section of acoustic cord.

7. Section of facial nerve.
8. Nucleus of facial n.
9. Sensory portion of lemniscus.
10. Pyramid.
11. Fibres of acoustic to funic. cuneat. et gracil. (to cerebellum).
12. Fibres of acoustic to corp. restiforme (to cerebellum).

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Fig. 2.

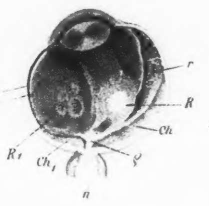

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Fig. 2.

Fig. 1.

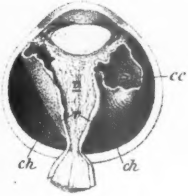

Fig. 3.

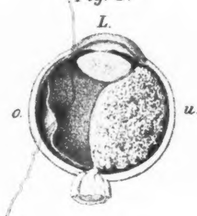

Fig. 4.

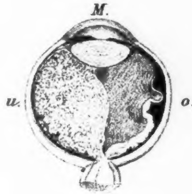

Fig. 5.

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